THE NEWSLETTER FOR LIGHTWAVE 3D ANIMATORS

LIGHTWAVE™ PRO

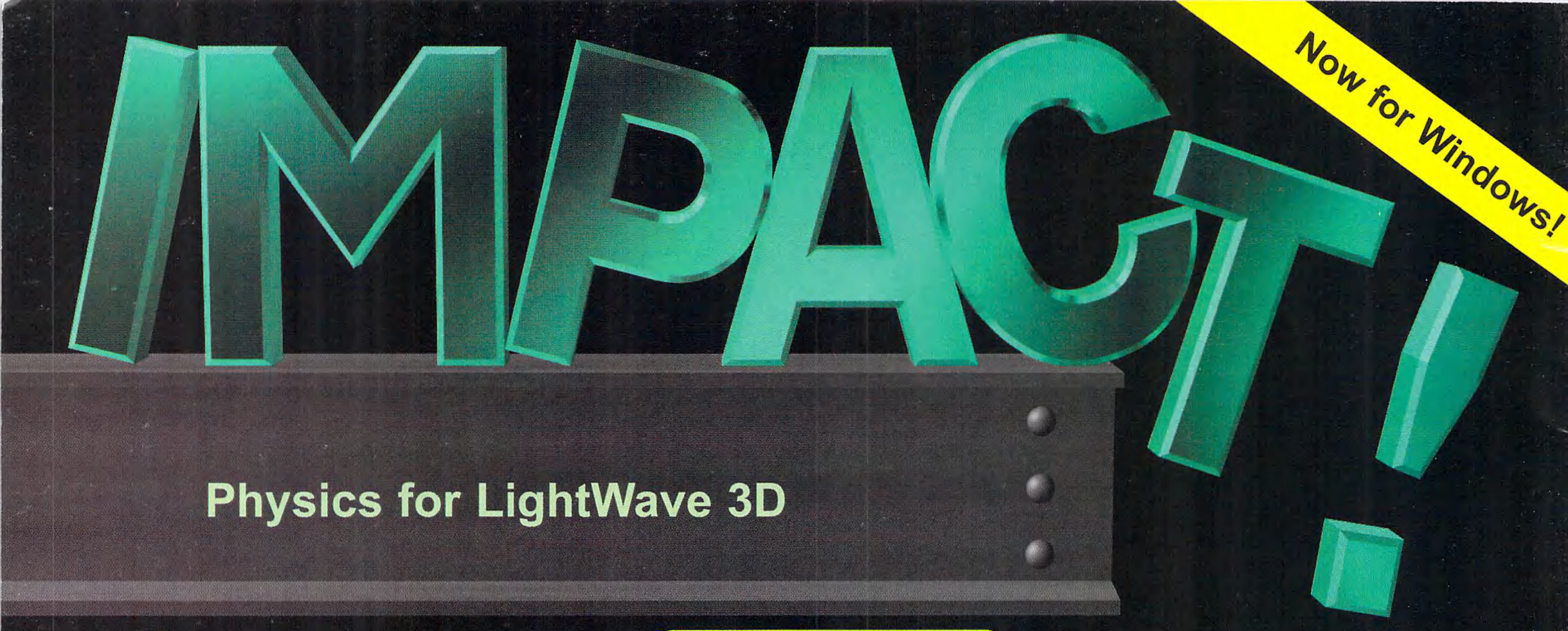
an Avid Media Group, Inc. newsletter

Volume 3 Issue Number 7 • July 1995 • $8.00

Computing Acceleration

MOVING FILES from AMIGA to PC

A FIRST LOOK AT Inverse KINEMATICS



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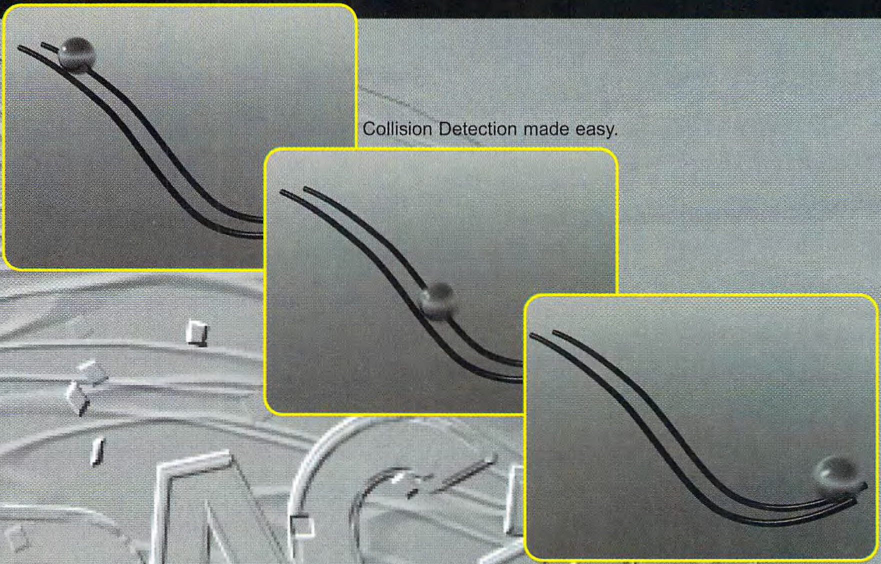

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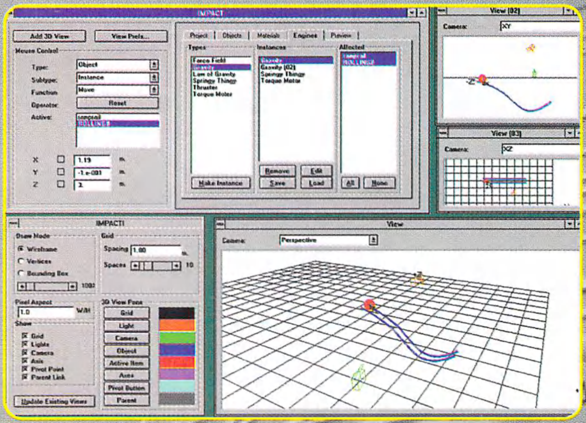
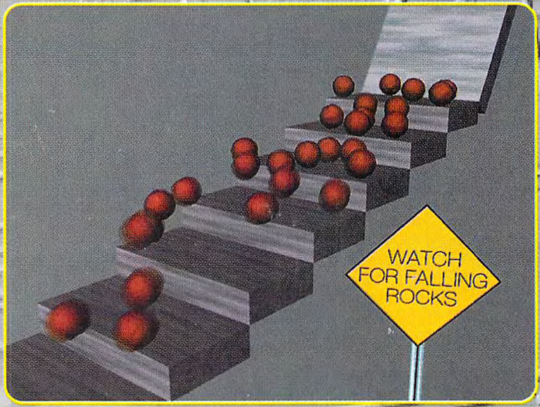

IMPACT
Add 3D View
View Prefs...
Mouse Control
Project
Objects
Materials
Engines
Preview
Types
Instances
Affected
Force Field
Gravity
Law of Gravity
Springy Thingy
Thruster
Torque Motor
Make Instance
Remove
Edit
Save
Load
All
None
View (02)
View (03)
IMPACT!
Draw Mode
Wireframe
Vertices
Bounding Box
Grid
3D View Pens
Light
Camera
Object
Active Item
Axes
Pivot Button
Parent
Update Existing Views
View

Type: Object
Subtype: Instance
Function: Move
Operator: Reset
Active: ampmail
X ☐ 1.19 m.
Y ☐ -1.e-001 m.
Z ☐ 3. m.
Instances: Gravity (02), Springy Thingy, Torque Motor
Camera: XY
Camera: XZ
Spacing 1.00 m.
Spaces 10
Pixel Aspect 1.0 W/H
Show
☒ Grid
☒ Lights
☒ Camera
☒ Axis
☒ Pivot Point
☒ Parent Link
Camera: Perspective

IMPACT! for Windows NT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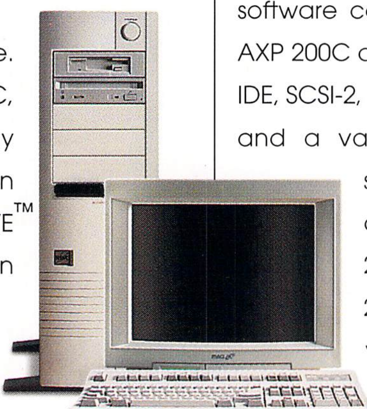

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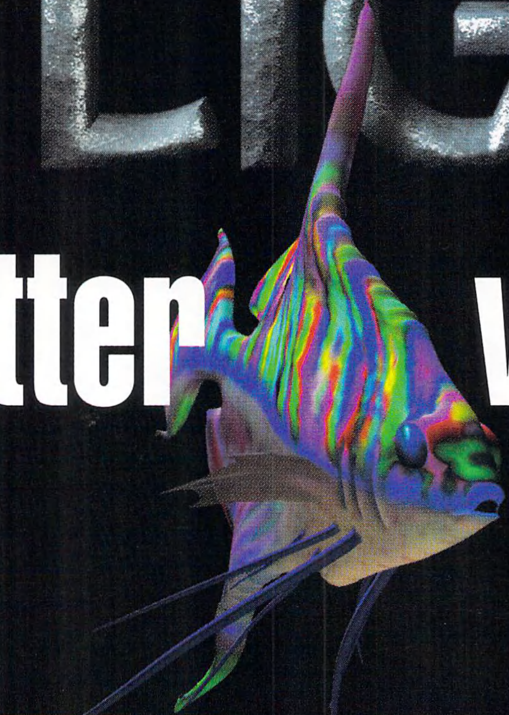

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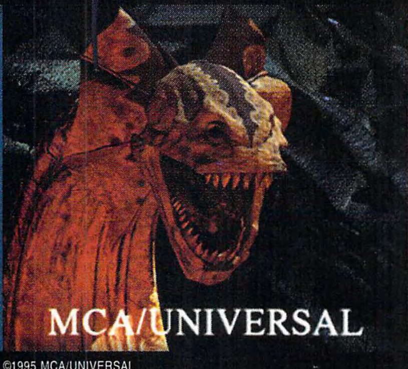

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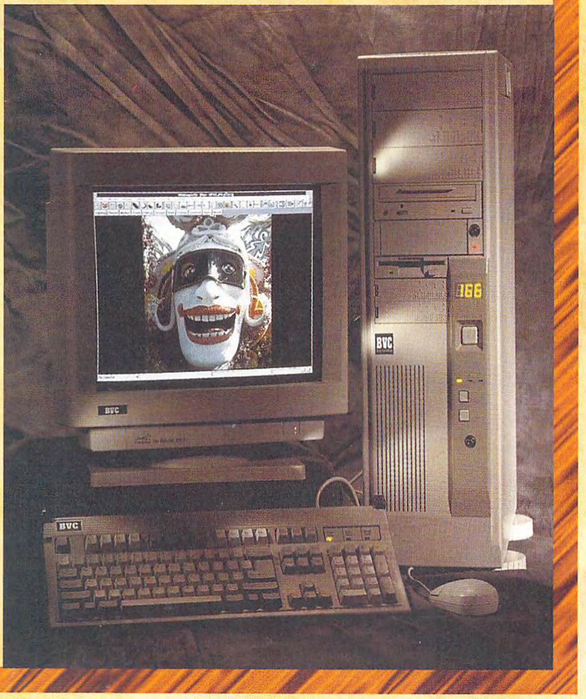

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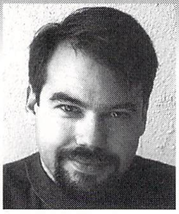

EDITOR'S MESSAGE

by John Gross

The Woes of a PC Owner

I thought I was going to be immune. I've owned computers for awhile now and have always been able to handle any problem that came up. I was usually clever enough to deal with it, fix it, make it work, figure it out, whatever. That was until I became a PC owner.

I should have seen the warning signs. Four of us from work bought systems from the same place. One of those had a bad motherboard from the start. Another one developed some problems with the hard drive about two months after being used. After another month or so, the third one had what appeared to be the same problem with its hard drive. A fifth employee went and bought the same system and had such bad luck with it out of the box that it he returned it about a week later.

During all of this, I was pretty cocky, because my machine was chugging away just fine. I wasn't experiencing any problems. Of course, I was warned that I had better back up my system because I was next. Hah! I thought, I'm the impervious PC owner. I shall experience no problems! But, being not entirely stupid, I borrowed a tape drive from work with the intention of backing up my system *just in case....*

I got home, hooked up the tape drive, started Windows NT and proceeded to install the driver. No problem there—everything installed fine and NT recognized the drive. NT informed me I had to reboot in order to use the new driver. Again no problem. After rebooting, I got a strange message stating that NT could not use my saved configuration and an earlier configuration was being used instead. Ahhh...OK. Once back into NT, everything seemed fine, so I went to the backup program, where I was informed that the system could find no tape drives. Hmmm. I went and looked for the driver, and sure enough, it did not show up, so I decided to reinstall it. When doing so, NT informed me that the driver already existed on the system. Would I like to reinstall it or use the current one? Hmmm. Obviously it accepted it the

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LIGHTWAVEPRO (Vol. 3, No. 7); (ISSN 1076-7819) is published monthly by Avid Media Group, Inc., 273 N. Mathilda Ave., Sunnyvale, CA 94086-4830. A one-year subscription (12 issues) in the U.S. and its possessions is $48 (U.S.); Canada/Mexico, $60 (U.S.); overseas, $84 (U.S.). To subscribe, call toll-free 1-800-322-2843. Allow 4 to 6 weeks for first issue to arrive. Second-class postage rate paid at Sunnyvale, CA and additional mailing offices. POSTMASTER: Send address changes to *LIGHTWAVEPRO*, 273 N. Mathilda Ave., Sunnyvale, CA 94086-4830.

About the cover: This month's cover image was created by Amblin Imaging for the Star Trek: Voyager *episode titled* "Emanations." *The entire shot was created and rendered in LightWave 3D. The* Voyager *object consists of 28 image maps (18MB of RAM), 281,435 polygons and 244 surfaces. Image courtesy Amblin Imaging, © 1995 Paramount Pictures.*

LightWave Tech

Making the Move

by Phillip J. Hice

I have had a large number of requests from Amiga users who now find it necessary to get all of those old Amiga animations and files, over to their new systems.

As stated last month, in this column I plan to address the ever-increasing need for converts from the Amiga to the world of PCs to transfer data from one system to the other. For those of you who have managed to figure this out on your own, never mind As for the rest, I feel that the suggested solutions are easy to understand and implement.

Software Utilities

In looking at software as a possible solution, several options arise. The first, and probably the one that most people who think that they have this figured out are using, is the old Amiga favorite CrossDOS (built into 2.05 and higher or available commercially). This utility enables the Amiga operating system to read, write, delete and perform all standard Amiga DOS functions on a PC-formatted disk via the Amiga floppy drive. With this utility you simply copy the data from your Amiga to the PC floppy disk, then transfer the diskette to the PC system and copy them to the local hard drive and you're done. One thing that you will need to remember in using this method, and a few I will discuss later is that PC DOS has the ridiculous limitation of only eight characters per filename, and a maximum of a three character extension. Because of this, any file on the Amiga that does not meet the PC DOS filename conventions will be truncated to match. That means, for example, that if you have files named "FrontLeftSideObject.02" and "FrontLeft TopObject.02," copying them over to the PC disk will truncate or rename them something like "FrontLe~.1" and "FrontLe~.2."

As you can see, if you have a large number of files with even slightly similar names, transferring them without first renaming them and creating a listing of what they were originally named can cause a world of headaches. Many of you may wonder why the eight-character filename is needed since Windows NT can handle larger filenames. While NT can write long file names to floppies, CrossDOS can't.

Another solution that is software-based uses a utility that most Amiga users who have transferred files via a modem will probably have: LH Arc. LHA is a software-only, data compression utility that lets Amiga users decrease the size of a file or multiple files for either modem transfer or archival purposes (to save hard drive space). The LHA utility for the Amiga is only one-third of the solution. The second part is a new version of the LHA utility that was designed specifically for Windows NT: LHANT. Unlike other PC DOS versions of LHA, LHANT utilizes the NTFS ability to handle long filenames, even if the file being de-compressed was compressed on an Amiga system. This will allow you to take a file named "LeftRearWing.part.02.a," and compress it on the Amiga, and when it is decompressed on the NT machine the filename will be completely intact. The third and final part to this solution is the inclusion of the first solution; you will need CrossDOS to transfer the compressed files. Once again, you should conform to the xxxxxxxx.xxx convention for the name of the compressed file, although it will not harm the compressed file in any way as far as data integrity. Naming the compressed file something larger than the eight-character limitation will result in CrossDOS truncating the filename when it is copied to the floppy. One other thing to keep in mind when using the LHA utility is that when you name your compressed files, it is not only good practice, but somewhat of a standard, to use the .LHA extension. This will enable you to immediately identify compressed files. It may not sound like a big deal, but it will be when you think that your data file is corrupted when no application on the planet can open it.

Hardware Solutions

The title "Hardware Solutions" is true only with the understanding that software will be required to run the hardware. There are several hardware-type options currently available, some of which require very little hardware or software knowledge. Others may not require any more initial understanding, but an ability to comprehend networking techniques.

The first hardware solution is both the least expensive and the easiest to install and operate. This solution requires the purchase of two things: a telecommunications software package for both of your computer systems (preferably one(s) that have the ZModem protocol, as it is currently the most efficient) and a null modem cable. When communicating via a modem, the connection between the modem and the computer is called a serial connection. In a serial connection, each device—in this case the host computer and the modem—has what are known in the industry as RS-232C serial ports. These ports are designed with the ability to both send and receive data on separate physical connections. So while one "pin"on the serial connector receives data, a different one is used to send data. This basic principle of the design allows for the use of what is known as a null-modem cable. This cable connects two computer serial ports in a crossover-type configuration in which the data out pin from one system connects to the data in pin on the other. By doing this the computers are able to establish, via telecommunications software, the same type of link that they would had they connected via modems/ phone lines, and they can upload or download files to and from each other.

Which leads me to the next hardware solution: modems. Although it is more expensive, you can usually get better transfer rates by directly connecting the two systems via modems and a phone cable. This is due to the fact that most modern modems have built-in hardware that compresses the data before transmitting it. Another reason why modems are preferable to the null-modem cable approach is that a null modem cable will only work if both systems have their serial ports set to transfer at the exact same speed, whereas with modems, each system can be configured to optimize the serial port for its best possible connection with the modem.

Networking

The final hardware solution I am going to discuss is networking. As most of you are aware, networking is currently the most effective means of transferring data between two systems, especially if these two systems are running different operating systems. Networking is also the most costly. These costs are increased by the number and types of machines that you have, as different operating systems will require different software to communicate over the network, and each system will require a NIC (Network Interface Card).

When I state that networking is the most expensive means of transfer, remember that network card prices start at around $100, so even though this process is more expensive, it doesn't have to break the bank. Because it is beyond the scope of this article to fully explain all networking aspects for Amigas and PCs, I am only going to discuss the most readily available means of networking for LightWave users—ScreamerNet.

As most of you know, ScreamerNet was added to LightWave for the purpose of connecting to external rendering engines, the first of which was the Screamer. Although ScreamerNet is part of LightWave, it was based on one of the oldest networking protocols TCP/IP. The TCP/IP protocol is extremely easy to implement, as you basically have numeric or IP addresses for each system on the network. These numbers are stored in an ASCII text file that the TCP/IP software uses for reference when trying to establish a remote connection, or when a remote connection is trying to be established with the host system. Although ScreamerNet takes all of its commands in the background from LightWave, all of the standard shell accessibility is still there. In order for the TCP/IP setup to work, you need only follow these steps:

(1) Install ScreamerNet onto your Amiga, if you don't already have it.
(2) Install the TCP/IP & FTP Networking Services on the NT machine.
(3) Update the TCP/IP reference text files with ScreamerNet address information.
(4) Set the Computer Name and Computer Address on the NT machine.
(5) Use the FTP protocol to establish connection, and transfer files.

The first item, installing ScreamerNet onto your Amiga, should be easy, as NewTek has created basic install disks to fully set up your Amiga system fully. Once this is done it is time to set up TCP/IP on your NT machine. In order to install the TCP/IP protocol you will need your original NT install disks or CD ready to go, as NT will need to load and install the proper drivers. (I am assuming that NT networking has already been activated. If this isn't the case, refer to your NT users manual for help in installing the network.)

In the Main group double-click on the Control Panel icon. Once the control panel window has opened, double-click on the Network icon. At this point NT will bring up a window that shows all of the network hardware and software installed. The first thing to do is select the button Add Software. This will bring up a window with a pulldown-style menu that will have a large list of all of the "built-in" networking software that NT can install. Scroll down the list until you reach the selection "TCP/IP Protocol and related components." Upon selecting this item, yet another window is opened that allows you to select from the various TCP/IP and related services. In addition to the connectivity utilities that NT pre-selects for you, you should also select the FTP Server service and the Simple TCP/IP Services.

After you have selected these, proceed by clicking on the continue button. NT will begin installing the needed drivers either from CD-ROM or from the floppies that it will prompt you for. During the driver install process a window will appear that warns you that FTP Server Service is not the most security-oriented application and ask you if you wish to proceed? Yes, you do. Failing to install the FTP Server Service will prohibit you from transferring files.

After the FTP drivers have been installed, yet another window will appear and prompt you for FTP information. You should leave all of these settings as they are except for the home directory setting. When a remote system, such as your Amiga, connects to your NT machine, this home directory is the path on the NT hard drive where the initial connection is made. I recommend setting this to a specific drive and directory that has the most free space available to store the received files. If you haven't set up this directory yet, you can multi-task out to file manager and create one, then go back and set the path. Once the path is set select the appropriate button to continue.

After all drivers are installed you will want to change the name of the machine to SCREAMER001 by simply clicking on the change button next to the machine name. After this is done, in the installed software window, select the TCP/IP services item and hit the configure button. This will bring up a window for you to install the TCP/IP address for this machine. The address for the machine named SCREAMER001 should be 200.000.000.001, and the default mask should be 255.255.255.255. Now you will be back at the main network settings window again. Click on OK or Close. Windows NT will display a horizontal bar graph showing the progress of rebuilding the network to include the changes you just made, then request that you restart your system for the changes to take effect. *Don't restart yet.*

Now for the last part of the software config. Run the notepad program located in the accessories group. Under the FILE menu option choose open. Under the D:\WINNT35\drivers\etc you will want to open a file named "hosts." In this file you will want to add the following lines as the last lines in the file:

```
200.0.0.200     amiga amiga ami
200.0.0.1       screamer001 d1
```

Once you have added these lines, resave the file with the same filename, and from the same location open the file titled "networks." In this file you will simply need to add the following line as the last line that reads:

```
AmigaNet        200.0.0
```

Then, as before, resave the file with the same name. Close the notepad program. Now you will want to shutdown and restart your NT machine so that all the changes you've made can take effect.

Now that you have the software installed, let's discuss how to use it to do the transfer. I prefer to establish the connection from the NT machine to the Amiga machine, the reason for which I will get into shortly. In order to make the connection the Amiga needs to have the ScreamerNet software running, which is done by simply double-clicking on the "Start Screaming" icon created by the ScreamerNet install disks. Starting this will cause a window to appear and state that the software has detected a second network card, but is ignoring it. Disregard this message, as it has nothing to do with what you are doing. After this is done, go back to your NT machine and open up the command prompt window by double-clicking on its icon in the Main group window. Here's where you really need to pay attention, and maybe even take notes.

From the shell window you should CD to the drive and directory that you selected as the home directory during the FTP setup. The reason for this is once the connection has been established you won't be able to change directories or drives on the local machine. You will, however, be able to move about the remote machines drives freely, which I will explain in just a moment. After changing to the home directory location at the prompt type FTP amiga, and hit enter. A message will appear asking for the user name to connect under. Type: screamer001 and hit enter. This will return another message requesting the password for the user screamer001. Type: toaster and hit enter. You should now receive a message that you are connected to amiga as screamer001 and receive the FTP> prompt. The first thing that you should do now is type binary and hit enter. This tells the system that you want to transfer binary information, not simply text, and you should receive a response of Type set to I, and then receive the FTP> prompt. At the prompt type DIR and hit enter. This will give you the listing of the Amiga's RAM drive, as that is the standard home directory on the Amiga for ScreamerNet. If you copy the files you want to transfer to the RAM disk, you will see them. If not, you can use the CD (change directory) command, with AmigaDOS paths to move to any other location on the Amiga's hard drives, including external Bernoulli drives and the like. Once you have

See LightWave Tech, page 18

Inverse Kinematics

by Mark Thompson

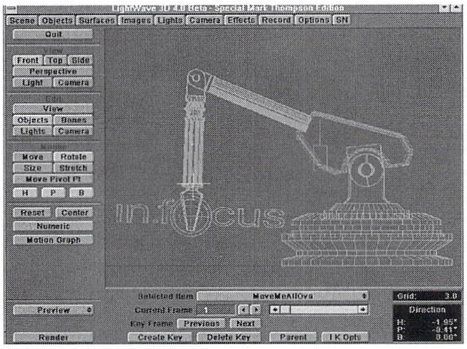
Character animation, the art of convincingly bringing life to a static character, has always been one of the most difficult tasks in animation. And it is in this area that LightWave has traditionally been weakest. Well, with the 4.0 release's addition of Inverse Kinematics (IK), this task just got a little easier. LightWave now allows you to use IK with bones or with hierarchical-linked objects.

Just a couple years ago, Inverse Kinematics could only be found on the most sophisticated, high-end 3D software packages. But with the advent of much more powerful PCs, IK is rapidly becoming a hot new buzzword among the desktop 3D crowd.

So what exactly is it? Regular kinematics have been a part of traditional animation all along. Whenever you define a set of keyframes for an object or camera, the resulting motion is a product of kinematics. Kinematics is the motion obtained from applying a set of translations and rotations to an object without regard for mass, friction, or other real-world physical forces. Inverse Kinematics, as its name implies, simply reverses these calculations to determine what translations and rotations are necessary to put an object into a specific position.

By itself, this does not sound like a particularly wonderful feat. However, when applied to an object hierarchy, it becomes a rather powerful tool. Consider a string of hierarchically linked objects. By using IK, you can place your end object in the hierarchy in the position and orientation you choose, and IK will determine how all the other connected objects in the hierarchy must move in order to bring the end object to that position. Without IK, you would have to laboriously move and keyframe each object individually. It quickly becomes apparent just how valuable this tool is for character animation.

People frequently confuse IK with dynamics. While both functions apply physical properties to determine an object's motion, IK is merely a tool to aid in setting up keyframes. Dynamics, on the other hand, completely calculates the object's motion without any user intervention. Dynamics takes into account friction, mass, inter-object collision, and other external forces. Once you start a dynamics calculation, there is no way to know exactly where the object will end up or the path it will take to get there. So while dynamics makes for realistic motion, the animator loses a great deal of control over the object. Also, because all the calculations necessary to figure out motion are based on forces and collisions, dynamics simulations can be extremely slow, taking several minutes per frame. Inverse kinematics calculations are far simpler; they may be performed in real time on a fast machine. Just keep in mind that on a 68040-based Amiga, IK can get a bit slow and jerky, and a 68030 is probably too slow to really be practical.



Selected Item: MoveMeAllOva

Current Frame: 1

Grid: 3.0

H: -1.95°
P: -0.41°
B: 0.00°

Figure 1: A simple IK scene setup. Moving the goal rotates each object in the IK chain so that the end object "points" toward the goal.

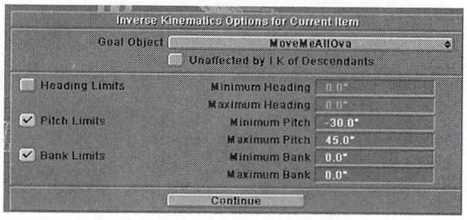
Getting Started

The first step in using Inverse Kinematics to animate a character is to set up a skeletal structure with Bones. This is no different than the Bone structure you would normally set up without using IK. However, the important step to using IK with bones is defining a hierarchy. Without a hierarchy, IK will not gain you anything. A typical hierarchy of Bones for a character might be something like "body -> thigh -> calf -> foot." You may also place additional child Bones in each appendage to yield better rigidity over areas that should not deform when the primary Bone structure is moved.

These "pinning" Bones are generally placed near the surface polygons to give a maximum effect of holding the points along the surface in place. For example, when defining the primary skeletal structure for a character's head, a single Bone might be used to affect its motion. But to keep the head from being deformed when that head Bone is moved, additional child Bones might be placed at the nose, ears, chin, back of the head, etc. This also helps reduce the influence from other Bones that aren't supposed to affect it, like those from an arm when it passes close to the head.

Once the Bones are placed and the hierarchy is defined, you must create a **Goal Object.** A Goal Object is one that will be used to target the motion of the end Bone in the hierarchy for each appendage. A null object is perfect for use as a goal. While in **Object** edit mode, hit the (+) key on the numeric keypad to create a new null. Then select the last primary Bone in the hierarchy for one of the appendages. With that Bone selected, hit the **IK Opts** button at the bottom of Layout and select the newly created null as the **Goal Object**. Now, as you move the goal object around, the entire hierarchy of Bones will align itself to allow the end Bone to point toward the goal. This is the fundamental capability that IK provides.

However, it is instantly apparent that what you currently have set up is pretty useless, since the entire Bone structure is swinging about erratically with every motion of the goal. You must first prevent the root Bones of the hierarchy from moving, namely, the body Bones. With the primary body Bone selected, hit the **IK Opts** button again. Note that there are numeric settings for each axis of rotation, along with a checkbox labeled "Unaffected by IK of Descendants." When this box is checked, the entire Bone is disabled from any IK influence. Check it and then try moving the goal object again. This time, the body stays in place while the leg and foot move about. But there is still another problem with the object's motion: nothing is preventing the leg Bones from spinning in any direction. You must constrain the motion to only certain axes and only through certain angles. To disable the IK motion of a Bone for one axis, in the IK Options window, set both the minimum and maximum angle to 0 degrees (or deselect that axis for that particular Bone). For axes that will move, set their



Inverse Kinematics Options for Current Item

Goal Object: MoveMeAllOva

☐ Unaffected by I K of Descendants

☐ Heading Limits

Minimum Heading: 0.0°

Maximum Heading: 0.0°

☑ Pitch Limits

Minimum Pitch: -30.0°

Maximum Pitch: 45.0°

☑ Bank Limits

Minimum Bank: 0.0°

Maximum Bank: 0.0°

Figure 2: The final shipping version of LightWave 4.0 has a much improved IK Opts panel.

minimum and maximum angle values appropriately. An easy way to do this is to manually rotate the Bone and visually note what correct maximum and minimum angles should be. Pressing the { key will toggle on the constraints for any axes that are selected and set their minimum angles. Likewise, the } key will set the maximum angles for any selected axes. Sometimes it helps to set limits interactively for one axis at a time.

Do this for each Bone in the hierarchy, eliminating axes that shouldn't turn and properly constraining those that do. When finished, try moving the goal object again. Note that this time, the appendage actually moves in a natural fashion, and with enough control so that IK is beginning to seem very useful.

Creating Keys

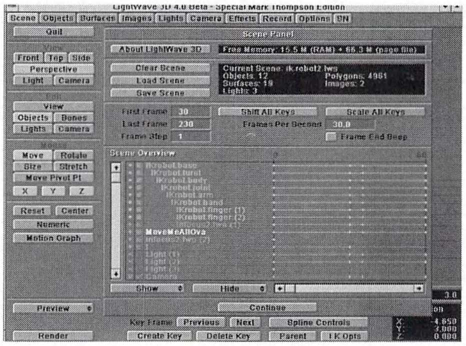
Now that Inverse Kinematics is producing viable motion for our limbs, it's time to set some keyframes. Before doing that, however, it's very important to note that goal objects are merely a keyframing tool for the hierarchy. Unlike a parent or target, they do not continuously drive the position of the Bones in the hierarchy. In other words, if you create a sequence of keyframes for your goal object based on how it moves in the hierarchy, you will find that making a preview reveals that the goal object moves, but the hierarchy it was set to directly remains immobile. Only when the goal object is manually moved do the Bones follow. Likewise, if you manually rotate one of the Bones in the hierarchy, the end bone will not continue to target or follow the goal object until, once again, the goal object is manually moved. Therefore, when using IK to define a motion, a key must be created for every bone in the hierarchy at each appropriate keyframe.

It is therefore more convenient to use the **Create Key for Selected Item and Descendants** option while switching back to the root bone when making each key, or simply use Create Key for **All Items**. The latter can be somewhat problematic, since it can foul up the motion of other items in the scene. When moving the goal object around to create your keys, you may find it easier to use the Front, Top or Side views, which help constrain the motion of the goal object.

You'll probably notice when placing the goal object that the Bone that targets it does not do so from the tip of the Bone, but from the base. In most cases, this is not desirable. To take care of this, add an additional child Bone to the end of the hierarchy and set its Rest Length extremely small. Then use this new bone to point toward the goal object rather than the previous Bone. This allows you to move your foot by the toe or ball of the foot rather than the ankle/heel area. This end Bone can be set to be inactive if you do not wish it to deform your object.

Thus far, we have only discussed using IK with Bones. But everything we have done with Bones works identically with object hierarchies. This is perfect for animating robots and other mechanical creatures. The only difference is in the case mentioned above with creating a small toe Bone. Instead, add a child null object. There is one drawback to this technique. Unlike organic characters, mechanized objects frequently have joints that extend. Unfortunately, in the current implementation of LightWave IK, there is only support for rotation, and no translation on any axis. So in the meantime, all mechanical extensions must be manually keyframed. This is not a big deal for simple extension joints, but for shock absorber-type mechanisms mounted on a rotational joint, things get a little more complicated.

Earlier, I mentioned that goal objects have no influence on their respective end effectors unless they are manually moved. This point leads to one other drawback. Imagine you are trying to make an animated human form ride a bicycle. The end effector would be placed at the ball of the foot and the goal object on the surface of the pedals. Ideally, the goal object on the pedals would be a child object of the bicycle crank. Then, as the crank was rotated, the goal object would follow around the path of the pedals. The problem is, LightWave IK does not influence the leg when a parent of the goal object is moved. Therefore, spinning the crank will rotate the pedals and goal, but the legs will remain stationary. What you must do instead is pick a few points around the path of the pedals, select the goal object, and very slightly jiggle its position to get the leg to respond to it. Then set keys for the hierarchy. You will probably have to do this for several points around the circumference of the circular path.



LightWave 3D 4.0 Beta - Special Mark Thompson Edition

Free Memory: 15.5 M (RAM) + 65.3 M (page file)

Current Scene: ik.robot2.lws

Objects: 12

Polygons: 4961

Surfaces: 19

Images: 2

Lights: 3

First Frame: 30

Last Frame: 230

Frame Step: 1

Frames Per Second: 30.0

☐ Frame End Beep

X: -4.850

Y: 3.000

Z: 0.000

Figure 3: The scene overview for our IK scene shows the hierarchical structure of the IK chain.

Before wrapping up IK, I wanted to point out the differences between the implementation in the pre-release 4.0 software versus the final release. The basic functionality is the same. The process of setting up the hierarchy and defining a goal point is common to both versions. But the pre-release did not have the constraint options the final release has. Instead of disabling a joint rotation in one or more axes within the IK Options panel, it was done by de-selecting the allowed rotational axes on the left side of the layout window. While this method works fine for simply disabling an axis, it leaves no way of constraining the rotation to only certain angles. The latter is critical in aiding the design of natural character motion. Fortunately, those who purchased the pre-release 4.0 product will get a free update to the final version (if they have not already).

Well, that about does it for IK. It is still a somewhat basic implementation and I look forward to future enhancements. Things I would like to see include X,Y,Z translations and the addition of frictional forces to make one joint or axis have a greater likelihood of moving over another. But in the meantime, IK has made the complex task of character animation with LightWave a little bit easier.

Mark Thompson is director of animation and special effects for Fusion Films, Inc., and producer of ProWave's in.focus LightWave training tape series. Send questions or comments to:

Fusion Films, Inc.
51 Derry Street
Merrimack, NH 03054
or e-mail mark@fusion.mv.com

Sorry:

In the May issue, it was stated that the June issue would contain Modeler benchmarks. Obviously, it did not. Modeler benchmarks will appear in an upcoming *LIGHTWAVEPRO.*

Real Textures

by Enrique Muñoz

Since the first version of our favorite 3D program, LightWave has had the ability to do procedural textures. With each revision, however, we've gotten a few more textures. In this article, I'll look at the most recent set of textures—specifically, Crust, Bump Array, Veins and Crumple.

This tutorial is not going to be the kind where you simply follow the directions and input some values. The point is to show alternatives to these new textures. I've learned through my own experience that just letting go and doing something, then going back and looking at what you did and understanding it, is the best way to learn how LightWave works.

Remember, these texture examples are just that: examples. These are the settings that I have found most useful, but getting the right surface setting with textures takes a lot of experimentation and testing.

Just One Plane

First we are going to need an object to place our texture on. Go into Modeler and select the Box tool. Make a 1.345-meter-by-1-meter plane in the Face view. Give this object any surface name you want and export it back to Layout. Move your camera up close to our object so that you can see the texture settings clearly (Figure 1). Using LightWave 4.0's Surface Sample spheres(s) is an alternative, but there are some problems involved. We will look at these problems in depth later in this article. If no surface setting is specified for a particular field, leave it at its default state. Before applying our values, let's think of what we can actually make.

Bump Array

This tool can be used to make textures with consecutive bumps for their all-around surface. Some good examples are golf balls, a skillet, the eyeballs of a fly and stained-glass dimples. Another thing that we can do with this texture is make snake skin. Huh? Well, think about it. What is real snake skin in its most basic form? A colored surface with dimples. Isn't this what Bump Array is for? Using this kind of thinking throughout this tutorial will help you understand the lessons and how to use these textures effectively. To get this surface, apply the following attributes:

Surface Color	0, 65, 80
Surface Color Texture	
Texture Type	Fractal Noise
Texture Size	0.1, 0.1, 0.1
Texture Color	198, 0, 0
Frequencies	4
Contrast	2.0
Diffuse Level	100%
Diffuse Texture	
Texture Type	Bump Array
Texture Value	50%
Radius	0.3
Spacing	0.1
Bump Strength	-0.5

Apply this to your favorite snake object, and voilà!

Crumply

When you think of Crumple, crumpled paper comes to mind. When you think of crumpled paper you start to think of something rough, like a rock. You can also use this texture on transparent objects, giving them a chipped-glass effect, especially if you have Trace Refraction turned on.

We could actually go to the opposite extreme and make sand! Just apply the following attributes:

Surface Color	180, 150, 100
Diffuse Level	80%
Diffuse Texture	
Texture Type	Fractal Noise
Texture Size	0.1, 0.1, 0.1
Texture Falloff	0.1, 0.1, 0.1
Texture Value	100%
Frequencies	2
Contrast	1.0
Specularity	15%
Color Highlights	On
Glossiness	Low
Bump Map Texture	
Texture Type	Crumple
Texture Size	0.5, 0.5, 0.5
Texture Falloff	0.5, 0.5, 0.5
Texture Amplitude	15%
Number of Scales	4
Small Power	0.75

One interesting thing about Crumple is that if the **Texture Amplitude** is set to a negative number, it will start looking like the Bump Array texture when you have the Spacing set to a smaller number than the Radius.

Veiny

What could we use the vein texture for, other than showing what the name implies? Things that come to mind are a flagstones-type texture (with a little work) and the hull of a spaceship (a la *Babylon 5*). If you're trying to re-create the hull of the *seaQuest*, here's your ticket to achieving it.

Our first example of using Veins to achieve a flagstones-type texture involves setting our Bump Strength to a negative number. We do this so the vein texture sticks in rather than out, which would cause the vein texture's "in-betweens" to look like little rock fragments. Next, change the **Coverage** and **Ledge Level** to a small number, so it appears as if it is the "cement" between the rock fragments.

To get the *seaQuest* texture, set your surfaces to a shade of dark blue and use Veins as your **Surface Color** texture, but with no **Bump Strength.** Next, use the texture in any of the other maps and use a center offset with a bump strength of -.5. This should give you something resembling a blue leopard (if there was one).

If you followed everything correctly or just want my specific settings, here they are:

Surface Color	0, 0, 60
Surface Color Texture	
Texture Type	Veins
Texture Size	0.1, 0.3, 0.1
Texture Color	55, 120, 205
Coverage	0.1
Ledge Level	0.1
Ledge Width	0.3
Bump Strength	0
Diffuse Level	90%
Specular Level	80%
Specular Texture	
Texture Type	Veins
Texture Size	0.3, 0.4, 0.2
Texture Center	1.0 (for all axes)
Texture Value	0%

Coverage	1.0
Ledge Level	001
Ledge Width	.175
Bump Strength	-0.75
Glossiness	Medium

Crusty

When I think of Crust I envision something organic (and sometimes gross). It doesn't always have to be used for just these purposes, though. Instead of having regular, patterned dots, like those you get with the Dots texture, you can now have randomly placed dots with variable sizes. By just putting the Ledge Level and Ledge Width fields to zero, we get rid of the edges and are left with just the dots. If **Bump Strength** is set to a negative number, we can get some results that we would have never thought imaginable. The moon is only one example. We can create this effect by using the texture in any two maps, such as a Diffuse and Luminosity or a Surface Color and specularity map (with different size offsets and centers). Remember, these textures don't just add a value—they also shade your surface.

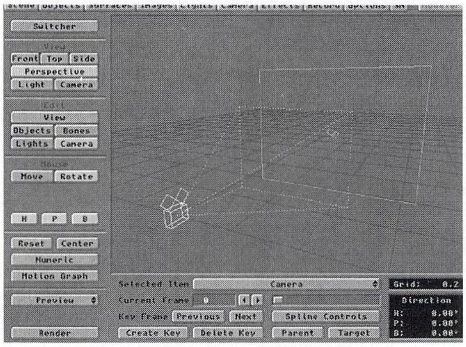


Figure 1: The simplicity of the Surface Test Scene

So what other tricks can you think of? Well, with a little experimentation, I've come up with a neat little tactic for forming condensation on the surface of the infamous Popcan included with LightWave. (You can actually use this trick with any type of object—a glass cup, champagne bottle, etc.)

- Go into Modeler and load the Popcan from your objects directory. Press the (q) key (or Surface under the Polygon menu). Name the new surface anything you want, and save it as a new object (WaterChill for this example).
- In Layout, load in both Popcans. Change the new Popcan's (WaterChill) pivot point to 0.062 on the Y-axis, because if it is sized from where the pivot point was, the Popcan will stretch from the bottom to the top. That's incorrect! It should size from the center to all its sides. Size it to a slightly larger margin. (For this example, change it to 1.03, 1.01, 1.03.)
- Go to the Surfaces panel and select your WaterChill surface. Apply the following attributes:

Surface Color	200, 200, 200
Diffuse Level	100%
Diffuse Texture	
Texture Type	Crust
Texture Size	0.01, 0.01, 0.01
Texture Value	100%
Coverage	0.3
Ledge Level	0.3
Ledge Width	0.4
Bump Strength	1.0
Specular Level	100%
Glossiness	Low
Reflectivity	20%
Transparency	100%
Refractive Index	1.33
Smoothing	On

Now just set your lighting, set up your layers of Refraction (see past issues of *LWPRO* for more information) and turn on Trace Reflection and Trace Refraction. Wait a couple of hours (seriously) and you'll have your own virtual pop can.

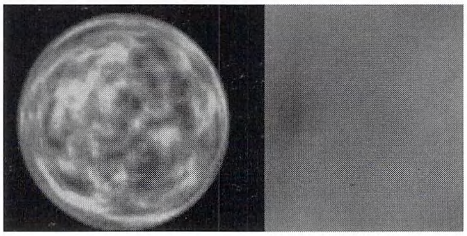


Figure 2: The difference between Surface Samples and actually rendering out the surface

Surface Samples Problems

The reason why I didn't want you to use LightWave's new Surface Samples was the many inconveniences associated with it. The first problem is that it (Surface Samples)doesn't take into account your global environment settings. What I mean is, it doesn't use the lighting you have set in your scene, or any fog settings or background images. Another problem is that it doesn't take into account what type of object this surface is going to be used on.

For a better understanding of the above sentence, do the following: load in the Gold Surface from your surfaces directory and render out our surface plane to your display buffer. What do you see? It should be a plane with darkness and brightness spots. Now render a Surface Sample by typing a lowercase (s). Do you see the difference between using Surface Samples and actually rendering out your real surface (Figure 2)? On your Surface Sample, you see a sphere with a completely different look. It has a surface that actually looks something like what a cow would have (a gold one, at least). Even though we have the exact same settings, we get different results. This happens because spherical reflection maps are computed upon different-shaped objects (in our case, a plane and a sphere). You will also get this problem when applying textures or images.

The moral of the story? Never commit to a surface without rendering out your object in its final environment with your surface settings.

Wrapping It Up

I've only covered a few examples of what these new textures can do here; at least a couple dozen more variables can be made. I've included the sample surfaces from this article and other surfaces that I have found most useful on the July *LWPRO* disk.

Enrique Muñoz is a senior animator for Digital Imaging, based in Ontario, Calif.

Tip of the Month:

With LightWave version 3.5, holding the shift key while clicking on an item's origin would select the item. This process was never very easy to do since an object's origin isn't visible *until* selected. Version 4.0 makes a big improvement on this. All you have to do is shift-click anywhere in the Layout window and LightWave will select the closest item to your click (object, Bone, light, camera). If you use a three-button mouse, pressing the middle mouse button will peform a shift-click. This works in any view and is really great for selecting an item to work on. In Modeler, the middle mouse button acts as if you are constraining a tool by holding down the Ctrl key.

Spinning Your Wheels, Part II

Acceleration and Thrust

by Joe Dox

Greetings all! In my last article (*LWPRO*, Feb. 1995), I showed how a LightWave animator can create actual wheel rotation at any velocity. This technique can be used to depict a car cruising down a road at 30 mph or a medicine tablet slowly rolling across a desk.

But these examples are of objects moving at constant speeds. What about accelerating from zero velocity? Decelerating from warp 9.75? Or accelerating a car from 0 to 60 mph with the tires rotating accordingly? Well, you can either get a third-party utility to help you out with this problem, or you can follow the steps outlined below.

If possible, before continuing, read the tutorial referred to above about wheel rotation and velocity, as I will be referencing formulas and things that were mentioned there. However, reading it is not required. I'll do my best to explain what's going on as we move along.

Acceleration Curves

Everyone's probably thinking: "Great! I can accelerate my car or ship from 0 to 60 mph in four seconds!" Well, it's not that simple. Acceleration is tricky, especially accelerating a wheel on a flat surface when factors like gravity and mass do not take part in the equation. In fact, what I'm about to illustrate will not result in a 0-to-60-type scenario at all.

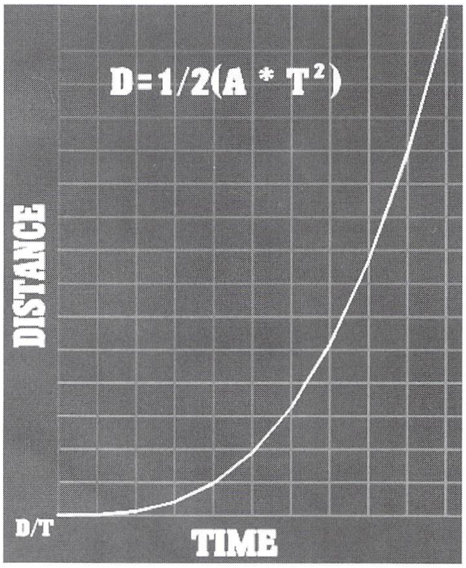
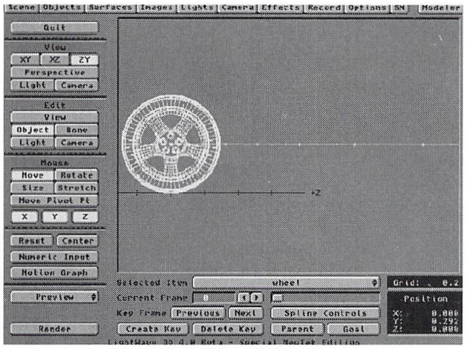


Figure 1: "Acceleration Curve" This curve was created by using the equation D = 1/2 x (A x (T x T)) to obtain an accurate change in velocity with respect to time.

What we need to do first is plot an acceleration curve (Figure 1). This curve depicts relative distance over time (velocity). Points are plotted at varying intervals from the results of an acceleration formula. Each point on the curve represents a particular distance traveled at a certain time interval. In other words, at each point we're traveling at a different speed, thus traveling a different distance (increasing for acceleration) at the end of each time interval.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Object
Bone
Light
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Mouse
Move
Rotate
Size
Stretch
Move Pivot Pt
X
Y
Z
Reset
Center
Numeric Input
Motion Graph
Preview
Render
+Z
Key Frame
Previous
Next
Spline Controls
Create Key
Delete Key
Parent
Goal
LightWave 3D 4.0 Beta - Special NewTek Edition

Selected Item: wheel
Current Frame: 0
Grid: 0.2
Position
X: 0.000
Y: 0.292
Z: 0.000

Figure 2: A wheel is applied to the acceleration curve. Note that distance and degrees of rotation are computed at each time interval.

To make a wheel accelerate on a flat surface, we simply need to compute the change-in-distance/change-in-time (delta-d/delta-t) and apply that velocity to the formula that, using the wheel's radius and circumference, computes wheel rotation at that specific velocity (see *LWPRO*, Feb. 1995). Simple, eh?

Constants and Variables

Let's begin. The example I'll be using is a wheel accelerating along the Z axis. We will be using the following equation:

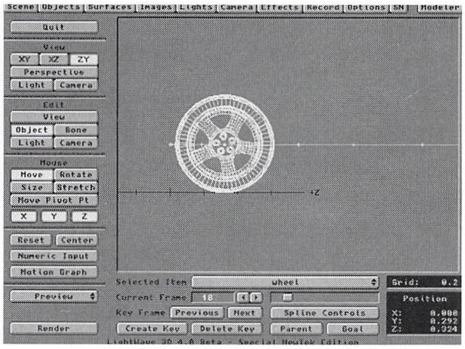
D = 1/2 x (A x (T x T))
where D = distance
A = acceleration
T = time

other variables:

K = "granularity of key framing"

The K variable is equal to how often a new keyframe should be created. For constant velocity, only two keyframes are required, as there is no change in velocity. For acceleration, velocity is changing at relative distances, so we must define how "granular" our acceleration should be. Ultimately, you should define this level of granularity to 1, which creates a keyframe at every frame. (I know, that's a lot of keyframes, but the effect is more realistic than creating new keyframes every 15 or 30 frames. Trust me, you'll see a difference.)

For this example, we will be accelerating a wheel along the Z axis, and we will compute a new relative distance and velocity every three frames. So, for this case, K = 3.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Object
Bone
Light
Camera
Mouse
Move
Rotate
Size
Stretch
Move Pivot Pt
X
Y
Z
Reset
Center
Numeric Input
Motion Graph
Preview
Render
+Z
Key Frame
Previous
Next
Spline Controls
Create Key
Delete Key
Parent
Goal
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Selected Item: wheel
Current Frame: 18
Grid: 0.2
Position
X: 0.000
Y: 0.292
Z: 0.324

Figure 3: The wheel has started accelerating. Distance = 0.324 meters.

In our acceleration formula above, we must also define T. That's simple, because we have already defined K (which is actually a factor of time). We are measuring relative changes in distance in seconds, or fractions of a second. So T would equal K/30 (T = K/30). For this example, T=3/30, or 1/10th of a second. This means we will be computing new distances (and degrees of rotation) every 1/10 of a second, or three frames. Of course we are assuming NTSC video rates of 30 frames per second here.

Next, we need to decide on an acceleration (A) fac-

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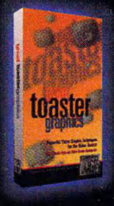

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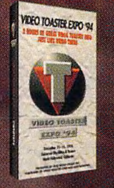

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LightWave Clapboard

Stenciling an object lets you travel in very close, without the pixelization common with image maps. See "lwpro@internet.online," page 12.

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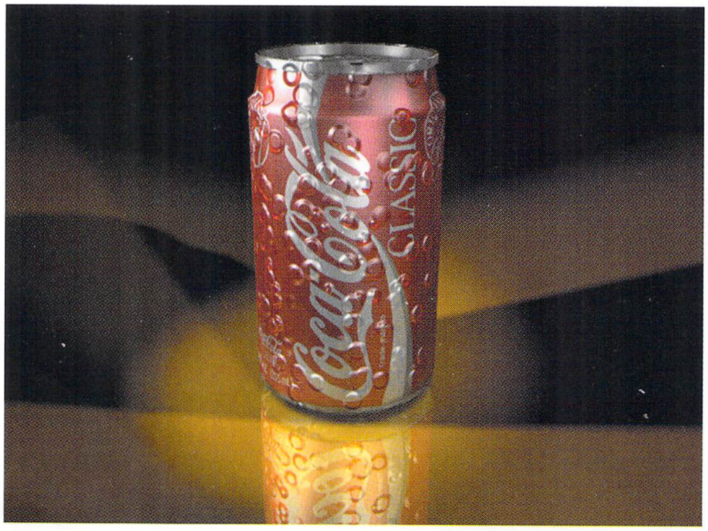
Robotics

A rendered frame of an animation using IK to set up robotic motions. See "Inverse Kinematics," page 6.

Copyright 1995 Mark Thompson

Inverse Kinematics
in.focus

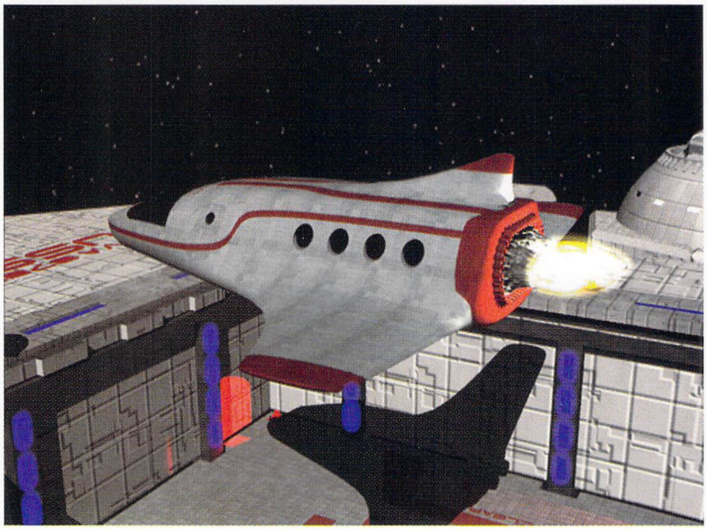

Coca-Cola
CLASSIC

Pop Can

A realistic-looking pop can using the Crust texture for condensation. See "Real Textures," page 8.

Copyright 1995 Enrique Muñoz

ANIMATION STILLS



Thrusters Firing

Using the formula D = 1/2 x (A x (T x T)), an animator can have ultimate control of acceleration and deceleration. Here, after the shuttle's thrusters have engaged, the ship smoothly accelerates away to earth. See "Spinning Your Wheels," page 10.

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Volumetrics

The results of using a volumetric shadow edge. See "Lords of Light," page 14.

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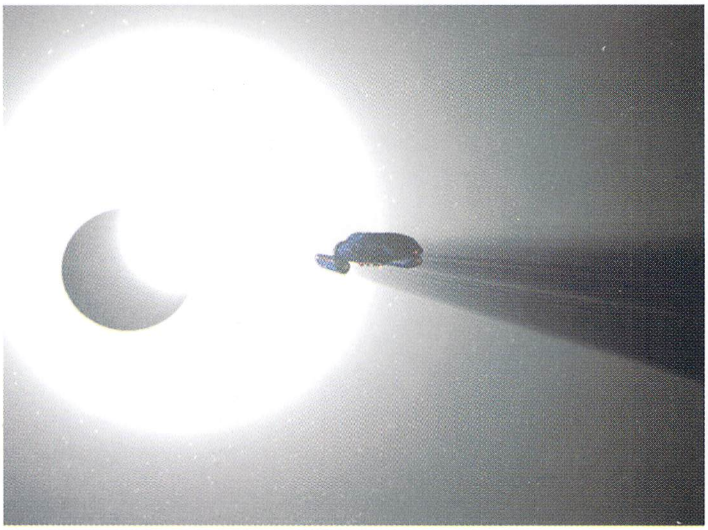

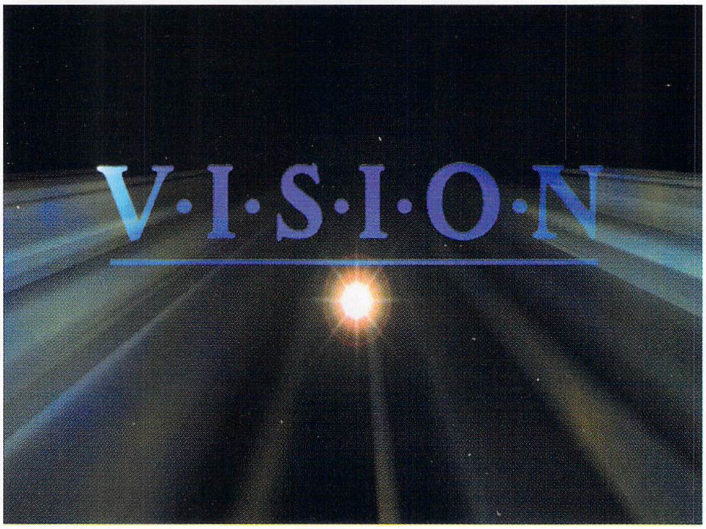

Sight for Sore Eyes

Art-nouveau use of fake volumetric effects for a logo treatment. See "Lords of Light," page 14.

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John Kennedy - AmigaFormat, Sept. 1994.

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Richard Baguley - Amiga Shopper, Oct. 1994.

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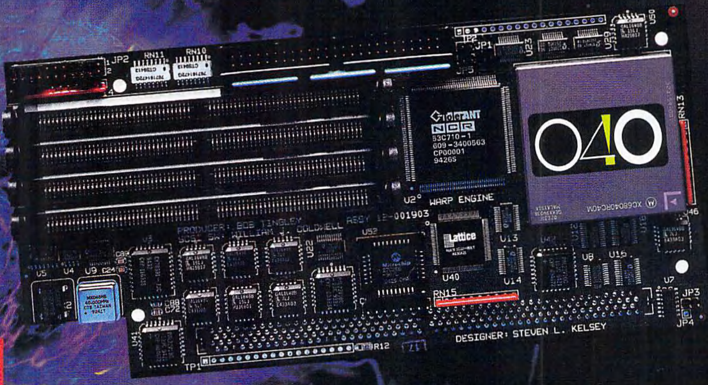

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tor. Think of this variable as how hard you step on the gas, or how much thrust your accelerating ship puts out. But also note that it is not a constant value throughout the time of acceleration. Instead, it increases by the value of A at each time interval. For example, at time-index 0, the starting value of A = 0.3; at time-index .1, A = A + 0.3; at time-index .2, A = A + 0.3; etc. It increases by the constant value of A. For our example, setting A = 0.30 will give us a nice acceleration curve.

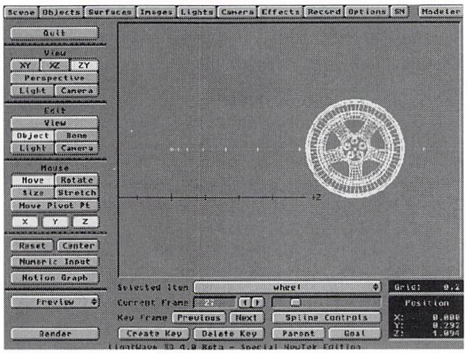
Increasing this constant will accelerate your vehicle faster. As an animator, this variable is one of those you will be changing to meet the needs of your imagery.

The fact that we are accelerating a wheel means that we need some information about the wheel. If you're accelerating a spaceship or a jet, you obviously would not need to compute degrees of rotation at every time interval. For this example, we need to establish the size (radius and circumference) of the wheel we are going to accelerate. In our example, the wheel has a radius of 11.61 inches (approximately .295 meters). That would make the circumference $C = 2 \times \pi \times .295$. Thus, C = 1.8535 meters.

Acceleration Formula

We are now ready to start computing our acceleration curve. Explaining it in prose may be a little confusing, so I'll describe the process in computer code-type form:

```
A = 0.3
T = 0.1
K = 3
C = 1.8535 (Circumference of wheel)
A_FACTOR = A
T_FACTOR = T
frame = K
old_distance = 0

Begin loop:
total_distance = 1/2 x (A x (T x T))
total_distance = 1/2 x (.3 x (.1 x .1))
total_distance = 0.0015 meters

delta_distance = total_distance - old_distance
delta_distance = 0.0015
old_distance =  total_distance

velocity = delta_distance x (30 / K)
velocity = 0.0015 x (30 / 3)
velocity = 0.015

delta_rotation = (( velocity / C ) x 360 ) x T_FACTOR
delta_rotation = ( 2.913 x T_FACTOR )
delta_rotation = 0.2913 degrees
total_rotation = total_rotation + delta_rotation

Move object to distance : z = 0.0015 meters
   (total distance)
 Rotate object # degrees : p = 0.2913 degrees
   (total rotation)
Create Key Frame #frame
A = A + A_FACTOR
T = T + T_FACTOR
frame = frame + K
End Loop
    <Repeat until you want to stop accelerating>
```



Selected Item: wheel
Grid: 0.2
Position
X: 0.000
Y: 0.292
Z: 1.094

Figure 4: The wheel is gaining speed. Distance = 1.094 meters.

I hope this formula is not too confusing. And remember, if you aren't accelerating a wheel on a flat surface, you don't have to compute degrees of rotation and velocity. The only thing you are interested in is the change in distance for each keyframe. An example of this type of application would be a spaceship or a rocket launch.

Deceleration

Now that we have covered acceleration, let's talk about deceleration. With acceleration, the object essentially starts at zero velocity and works its way up the curve. Deceleration is the opposite. We start at a specific velocity (or time index) and work our way down to zero velocity.

Before we "hit the brakes," we must define the length of the animation. This will be the condition of the computational cycle. With acceleration, we can speed up infinitely, until our ears fall off. But with deceleration, we can only go down to zero velocity, so we must define how long it will take to decelerate our object.

The T_FACTOR constant can remain the same. This is simply a value that we will subtract from the T variable. So we'll leave T_FACTOR = 0.1, and our animation at 150 frames (five seconds). We will also leave the value of K, which is the keyframe "granularity," at 3. With these variables set, we know that the animation will have 50 keyframes, and a starting value of T = 5. What about A_FACTOR? The A_FACTOR variable will also remain the same, for it is a constant that never changes. But we do need to set the variable A to a new starting value. We know that there are 50 keyframes, and the A_FACTOR = 0.3, so A = 0.3 x 50 = 15.

Now that we have our new starting values, let's go through a deceleration formula:

```
K = 3
C = 1.8535 (Circumference of wheel)
A_FACTOR = 0.3
T_FACTOR = 0.1
frame = 0
max_frames = 150
key_frames = max_frames / K
old_distance = 0

A = key_frames x A_FACTOR = 15
T = max_frames / 30 = 5

Begin loop:
total_distance = 1/2 x (A x (T x T))
total_distance = 1/2 x (15 x (5 x 5))
total_distance = 187.5 meters

 if (old_distance = 0 ) delta_distance =
   total_distance
 else delta_distance = total_distance - old_distance
 delta_distance = 187.5
 old_distance  = total_distance

 velocity = delta_distance x ( 30 / K )
 velocity = 187.5 x ( 30 / 3 )
 velocity = 1875

 delta_rotation = (( velocity / C ) x 360 ) x
   T_FACTOR
 delta_rotation = (364175.88 x T_FACTOR)
 delta_rotation = 36417.588 degrees
 if (total_rotation = 0 ) total_rotation =
   delta_rotation
 else total_rotation = total_rotation -
   delta_rotation
 Move object to distance : z = 187.5 meters
   (total distance)
 Rotate object # degrees : p = 36417.588 degrees
   (total rotation)
Create Key Frame #frame

A = A - A_FACTOR
T = T - T_FACTOR
frame = frame + K

End Loop (Repeat while T >= 0)
```

Note that the formula above is similar to the acceleration formula, with a few exceptions. One difference is that we are starting with different values for A and T, and there is a max_frames variable needed to define T, which is also the loop conditional. We are subtracting from A and T because our velocity is decreasing down to zero. When rotation is computed, you'll see that the delta_rotation is subtracted from the total_rotation because the velocity and distance traveled is decreasing at each keyframe. Again, to create the effects to meet your needs, simply experiment with different values of A_FACTOR and T_FACTOR.

See Spinning Your Wheels, page 13

lwpro@internet.online

by Dan Ablan

With this, our second installment of the *LWPRO* Internet column, we hope to inform not only those connected to the Internet, but also those who are not. It seems from recent surfing that regardless of the amount of conversations, questions and basic information floating around, there are many who post and request LightWave "how-tos." So each month, this column will provide a "mini" tutorial based on recent Internet activity and questions.

First off are some interesting topics of discussion on the LightWave newsgroups. There has been much talk about LightWave 4.0 benchmarks. Questions have come up regarding system recommendations, video cards, and other factors involved in adding a PC to your animation setup. John Gross and Phillip Hice put together a very informative benchmark article for the May 1995 *LWPRO*, so check it out. Also, there has been much discussion about LightWave's Bones feature. Here's a quick list of Bones tips:

- Think of Bones as handles to pull and push an object.
- Bones affect the points of an object, not the polygons. That means if you wanted a pop can, holding a hat object to bend and jump, the hat would have to be part of the pop can. Parented objects are also not affected by Bones.
- Objects need to be tripled, and often subdivided, to bend an object properly.
- The Rest Length of a Bone sets the amount of influence on the object. The longer the Rest Length, the more influence. Normally, more, smaller Bones give better control than larger, fewer Bones.
- Sizing a Bone actually changes the size of the object, not the Bone. This function is a great way to simulate breathing or muscle contractions.
- With LightWave 3.5 and up, you can use Add Child Bone to save time when setting up a chain of Bones. You would use a chain of Bones for objects like a tail or a swimming fish.
- Once the Bones are set in place with an object, it's a good idea to save a setup scene. At that point, the scene with the Bone movements and keyframes should be saved under a different name.
- Be patient in your Bone movements. Don't try to do too much in a small number of keyframes.
- Try stretching the object while moving Bones for added characteristics.

[Editor's note: Bones have changed significantly with 4.0. Look for a future article on LightWave's new Bones.]

As promised last issue, here's some cool web sites to visit while cruising the net:

People-Related Sites

www.ovaug.org
iac.net/~bcleach/index.html
www.mcs.com/~dma/home.html
www.mcs.com/~munster
mat075207.student.utwente.nl/~martin

3D-Related Sites

www.lightside.com/~dani/ad.html
www.webmaster.com/newtek
register@nab.org/default.htm
www.desktopimages.com
www.siggraph.org
kuhttp.cc.ukans.edu/cwis/organizations/kucial/uroulette
www.datalabs.com
www.mcs.net
tomahawk.welch.jhu.edu

The http://www.lightside.com page is an interesting place to visit. It is a web site dedicated to the art of 3D. Here, you can see images created by other 3D professionals, beginners and hobbyists.

This month, while preparing my reservations for the SIGGRAPH convention in Los Angeles, I realized that the previous year's method of registering was now obsolete. By visiting the SIGGRAPH home page, at http://www.siggraph.org, I was able to not only find a '95 conference registration form, dates, times, and locations, I could also book a hotel room from the many listings, which included addresses, phone numbers and street maps.

Of course, this is just a minor sample of the incredible number of sites available through your Internet connection. Each month, as we discover new and exciting places, look to *LWPRO* for up-to-date listings.

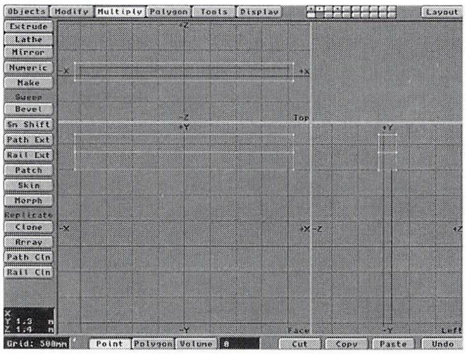


Figure 1

Many of the sites listed above also have links to other sites, so be prepared to stay on-line for a while.

Using Stencil

Now for the Internat tutorial. There has been quite a bit of jabber lately on how to use LightWave Modeler's "Stencil" feature. Stencil is a powerful Boolean operation that allows you to cut polygons into polygons, like a branding iron. There are many advantages to having this function, one of which is putting text on an object. Too often, time is wasted making an image map, properly sizing, and then worrying about how close you can get to an object, due to pixelization. If you stencil an object, you'll have none of these problems. For example, you need to make a director's clapboard for your animation demo's opening countdown. What's the best way to do it? Stencil!

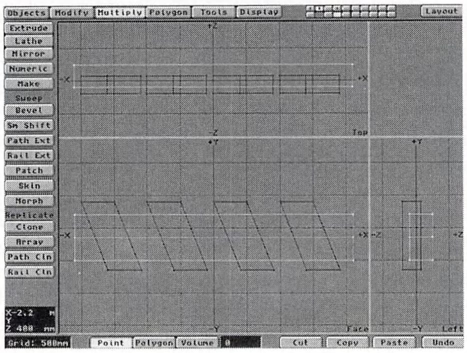
Step one:

- Build the clapboard by making a box using these settings, in meters:

Low	High	Segments
-2	2	1
-1.5	1.5	1
0	0.15	1

- Next, you'll need to model the top (clapping) part:

Low	High	Segments
-2.1	2.1	1
1.5	1.85	1
-0.1	0.25	1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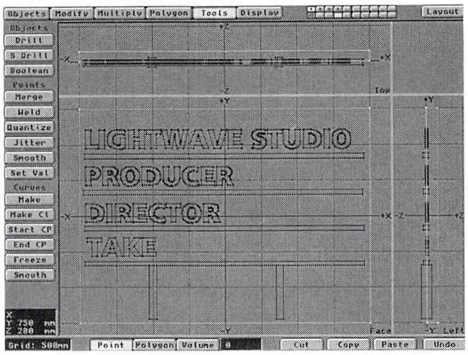
Path Ext
Rail Ext
Patch
Skin
Morph
Replicate
Clone
Array
Path Cln
Rail Cln
Top
Face
Left
Grid: 500mm
Point
Polygon
Volume
Cut
Copy
Paste
Undo

Figure 2

- Once you've done this, copy it, then move it up, on the Y axis equal in distance to its size. Then paste. Instead of trying to make two identical pieces, it's easier to make one, copy and move it, then paste back the original (Figure 1).
- Now, make the white diagonal lines that go across the clapper part of the object. With the clapboards in a background layer, draw out a box in a new layer that intersects on the Z and is taller on the Y. Select the top points of the box and drag to the left to put a slant in the box. Clone this three times (Multiply menu) with an offset of one meter on the X (Figure 2). Give a surface name to the original object of "Black."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Make CL
Start CP
End CP
Freeze
Smooth
LIGHTWAVE STUDIO
PRODUCER
DIRECTOR
TAKE
Top
Face
Left
Grid: 500mm
Point
Polygon
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Copy
Paste
Undo

Figure 3

- Next, it's time to stencil. Make sure that the object to be stenciled is in the foreground, while the object that will do the stenciling is in the background. This arrangement applies to Boolean operations as well. Under the Tools menu is S Drill, or Solid Drill (you can also use shift C). Select stencil from the menu and enter a surface name of White. Click OK. In a few moments, you should have diagonals on the top portion of the clapboard object. Now save it out.
- The next step is to stencil in text on the main clapboard. Pick a font that you like and type out the name of your company, producer, etc. I chose to use the text macro to create one page of text that is evenly aligned on the left. It is highly recommended that you separate each word into individual layers, as stenciling the whole page would take a drastic amount of time.
- Using the same procedure as before, the stencil (words) should be lined up in the background layer, slightly intersecting the clapboard. Also, you'll probably need to re-size the words so they fit onto the clapboard. In the size requester, .35 worked as a good number for bringing down the size of the words. Once you've stenciled each word, save the object. For an added look, I called up a scripty-type font, resembling handwriting and filled in the blanks on the clapboard by also using the stencil tool (Figure 3).

A complete modeling job like this takes no time at all. The stenciling may take you a while longer as your computer takes some time to calculate and render these objects. The results, though, are well worth the wait. By using the Stenciling process, you can create objects that are clean and useable, even closeup (see color image).

LWP

Dan Ablan is president of AGA Digital Studios in Chicago, Ill. He can be reached via e-mail at dma@mcs.com.

Spinning Your Wheels

continued from page 11

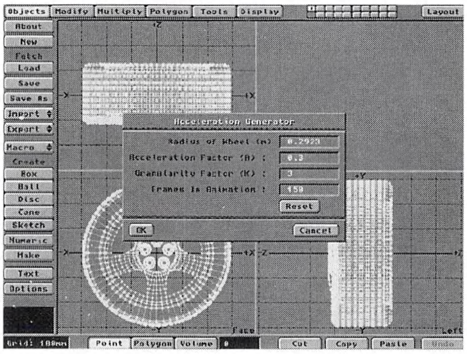
Acceleration and Deceleration Macro

What you need to do now is apply different values of A, K and T to make the motions you want. To simplify things, I've created a macro that generates acceleration motion files based upon the values of A and K entered by the user. Other variables, such as starting X,Y,Z offsets and total frames, are also entered by the user.

For those of you who want to accelerate your spaceships (no rotation needed) using the macro, simply leave the "Create acceleration with rotation" toggle off. I have also made a deceleration macro that helps "accelerate" the process of decelerating your objects. These macros are in Amiga ARexx format only.

This lesson has a number of applications. Missiles firing, drag races, jets taking off, ships entering warp, whatever! I hope this information proves useful to you all.

LWP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Sketch
Numeric
Make
Text
Options
Face
Left
Grid: 100mm
Point
Polygon
Volume
Cut
Copy
Paste
Undo
Reset
OK
Cancel

Acceleration Generator
Radius of Wheel (m) 0.2923
Acceleration Factor (A) : 0.3
Granularity Factor (K) : 3
Frames in Animation : 150

Figure 5: The Acceleration Macro makes it easy to accelerate or decelerate your objects.

Joe Dox operates Galaxy Imaging (formerly Galaxy Video & Animations) near Boston, Mass. He has been using LightWave since version 1.0, and is currently doing work for a Boston television station and other various companies in the region. To reach him for comments or suggestions, call (617) 334-6165, or e-mail jdox@galaxy.shore.net.

Creating Realistic Acceleration Curves

(1) Define how often to create a new keyframe (K).

(2) Define acceleration factor (A).

(3) Define time factor (T) equal to K/30.

(4) Define length of animation.

(5) Start counting up from starting frame.

- Compute D = 1/2 x (A x (T x T))
- If accelerating a wheel on a flat surface, compute the rotation of the wheel.

(6) Create keyframe for distance traveled and rotation.

(7) Increment A and T by their initial constant value. If decelerating, you must decrement A and T.

(8) Increment framecount by K.

(9) Repeat until you're done.

In the August Issue:

Next month's *LIGHTWAVEPRO* starts the in-depth exploration of LightWave's 4.0's new features.

Lords of Light

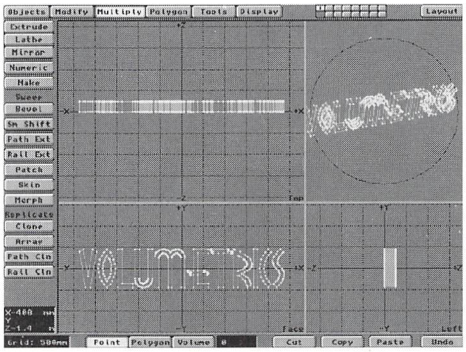
Faking Volumetric Lighting, Part II

by Alan Chan

In my many years of production work, I have never heard a more descriptive, tantalizing definition of what cinematographers are than Lords of Light. It is the director of photography (DP)'s job to tell the story with images. Painting with light is much more than setting a key, a fill and a rim light. It is a craft fine-tuned by a lifetime of experience.

We are all in the business of images, and the line between real and CG images is already a thin, blurry one. Just like a cinematographer, our computers give us the ability to paint with light. And just like a cinematographer, it will take us a lifetime to learn all the ins and outs.

LightWave animators are, perhaps, the digital equivalent of the cinematographer (and much more). As such, a good understanding of lighting theory is a big plus. (If you haven't given much thought to lighting in your animations yet, I suggest you start as soon as possible.) The tips and tutorials in parts I and II of this article work best in the hands of those who integrate them into a well-thought-out lighting scheme. In the end, it's all in the lighting.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Patch
Skin
Morph
Replicate
Clone
Array
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Rail Cln
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Figure 1: The logo to be extruded

Last month we looked at re-creating beam spotlights and using cut-out patterns to shape the beam. This month we'll push on further and examine some methods of faking volumetric shadows.

Volumetric Logo Shadows

Now that you've got the basics down through last month's article, the next little step must be to create the shimmering logo shadow. Whether you're going for the extra-realistic or the hyper-real artsy look, the basic construction is the same. The difference lies in the surfacing. Let's go through a quick session on building the object, then explore several different options and ways of surfacing. The trick to volumetric shadows is that you have to understand what each setting does, and how they interact with every other little setting to achieve the look you want, rather than just a standard, "click-on-Volumetric-setting-and-render" generic look. So pay attention.

Basic Construction

As I mentioned earlier, in faking volumetric shadows we are concerned with the edges of the given volume. Creating volumetric lighting for flying logos, is somewhat simple. Because most logos are essentially 2D in nature, we can use the outline of the logo itself to create the shadow shape.

Let's say, for instance, that you've scanned in or created, using the Text tool, the following 2D logo (Figure 1), and then extruded the logo to give it some depth.

- Make sure the front face of the logo is at Z = 0 (assuming, of course, that you're building it in the Z axis).
- Using the right mouse key, lasso-select all the polygons on the front face, and copy and paste them in a different layer (Figure 2). Extrude this in the -Z direction, away from the logo itself, a distance sufficient to your needs. (I usually extrude the object about 25 to 30 times the extruded length of the logo.) This will be our volumetric "shadow edge." Select the polygons at either end of the extrusion and cut them away, which again leaves a hollow object in the shape of the logo (Figure 3).

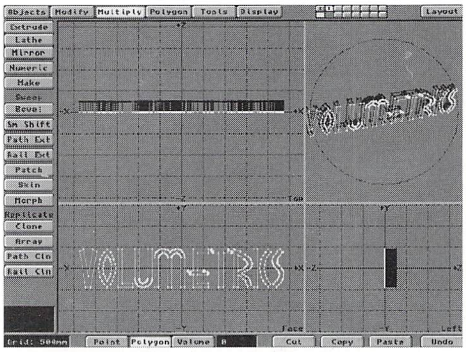

Objects
Modify
Multiply
Polygon
Tools
Display
Layout
Extrude
Lathe
Mirror
Numeric
Make
Sweep
Bevel
Sm Shift
Path Ext
Rail Ext
Patch
Skin
Morph
Replicate
Clone
Array
Path Cln
Rail Cln
Point
Polygon
Volume
Cut
Copy
Paste
Undo

Figure 2: Copying the front face to a new layer

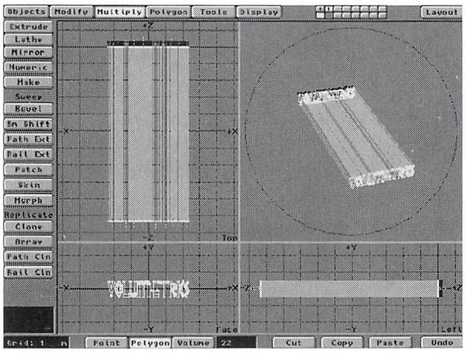

Objects
Modify
Multiply
Polygon
Tools
Display
Layout
Extrude
Lathe
Mirror
Numeric
Make
Sweep
Bevel
Sm Shift
Path Ext
Rail Ext
Patch
Skin
Morph
Replicate
Clone
Array
Path Cln
Rail Cln
Point
Polygon
Volume
Cut
Copy
Paste
Undo

Figure 3: The extruded shadow edge

- One final thing: make sure the lightbeam polygons are facing inward. If they're not, select all the polygons and perform a Flip function (Polygon menu) on them. That way, when the lightbeam is rendered, only the edge furthest away from the camera point of view is rendered. Give the surface a name and export it to Layout. Make sure to parent the volumetric lightbeam object to your logo.

  You now have a volumetric object ready to surface!

The Realistic Look

The realistic look presupposes a lightsource behind the object and a sort of hazy (read: foggy) day, so you might want to begin by adding a little fog to your scene if you have objects in the background as well. Figure 4 shows an example of a realistic volumetric lighting scene. For this scene, the surface settings for the lightbeam object are as follows:

Surface Color	9,10,20
Luminosity	100%
Diffuse Level	0%
Transparency	0%

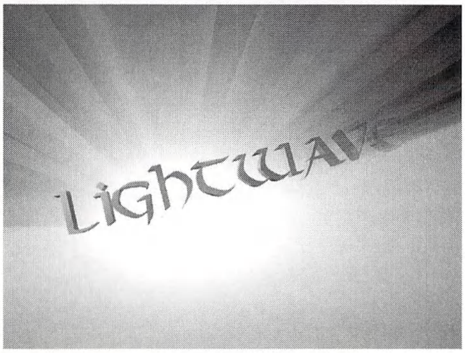


Figure 4: An example of volumetric shadows

Transparency Texture	
Texture Type	Grid
Texture Falloff	0,0,10.0
Texture Value	75%
Line Thickness	1.0
Edge Transparency	Transparent
Edge Threshold	2.5
Smoothing	On
Double Sided	Off

In addition to the streaks of light, two flares named FlareStreaks and FlareGlow were parented to a null object to provide the "practical" light source:

FlareStreaks	
Flare Intensity	200%
Flare Dissolve	70%
Central Glow	On
Red Outer Glow	Off
Glow Behind Objects	On
Central Ring	Of
Random Streaks	On
Anamorphic Squeeze	On
FlareGlow	
Flare Intensity	300%
Flare Dissolve	0%
Central Glow	On
Red Outer Glow	Off
Glow Behind Objects	On
Central Ring	Off
Random Streaks	Off
Anamorphic Squeeze	On

(all other settings are left at their default values)

FlareStreaks is 70% dissolved to provide just a hint of lightstreaks, whereas FlareGlow is the primary flare in this combination. Using multiple flares gives precise control over certain parameters—in this case the slight random streaks effect, which would be too overbearing if we only had one flare control.

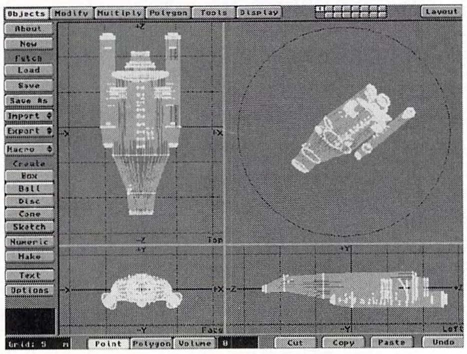


Figure 5: The spaceship object loaded into Modeler

Note that the volumetric surfaces for this scene work to the contrary of the additive process that we've been doing with the lightbeams tutorial. The surface color is very close to black, and in conjunction with the bright background flare, works almost like a subtractive process, darkening the shadow areas. (It's "deleting" light instead of adding it, which, if you think in terms of real volumetric shadows, is scientifically accurate.) Also, the transparency settings are flip-flopped. The transparency of the shadows actually begins at 75% near the logo and gets progressively more opaque the further away it gets, which is technically incorrect. However, for our camera angle this inaccuracy is unnoticeable and actually more aesthetically pleasing.

The Artsy Shadow

For our animated company logo we made a decision not to have the logo do any sort of fly-in. We opted instead for exaggerated lens flares and an art-nouveau type of volumetric shadow (see color pages). The surface settings are:

Surface Color	0,60,200
Surface Color Texture	
Texture Type	Fractal Noise
Texture Size	0.05,1.0,1.0
World Coordinates	On
Texture Color	229,197,45
Frequencies	3
Contrast	0.5
Luminosity	100%
Diffuse Level	0%
Transparency Texture	
Texture Type	Planar Image Map
Texture Image	Cookie.iff
Texture Axis	Z Axis
Automatic Sizing	
Texture Velocity	0.007,1.0,1.0
Edge Transparency	Transparent
Edge Threshold	0.15
Smoothing	On

Note that the transparency values here contain a very slight velocity setting to cause a slow movement of the texture across the shadow object. Also, with the surface color texture set to Fractal Noise and World Coordinates, a patchy-smoky look is added.

Objects in the Particle Stream

When I began writing this article I asked members of the LightWave mailing list on the Internet for specific examples of volumetric lighting. One of the requests I got was to achieve something similar to the final shot in the *Star Trek: Voyager* opening sequence, where the neighborhood sun flares up and floods all of space with volumetric light. (Yeah, well, we all know that don't happen in space, pardner.) The lighting effect for that sequence was generated by Santa Barbara Studios using another software package, but we can easily achieve this effect in LightWave using some of the concepts from last month's article.

- Begin by loading up your favorite spaceship object into Modeler. If you're like me and you built your craft with several different movable parts, you'll need to load the objects into Layout, use Save Transformed and load all the transformed objects into one layer so they are all in their relative positions (Figure 5). Remember, however, to reset your position, rotation and scale for your main parent object first, to ensure that your shadow edges can be easily matched up later.

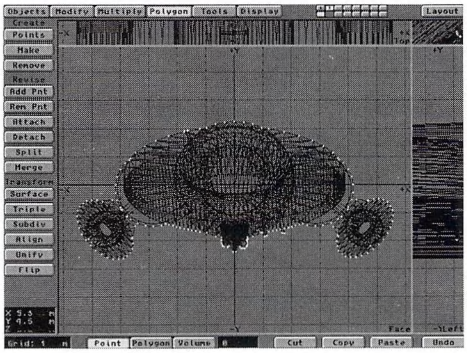


Figure 6: Points comprising the outer edge of the ship

Now, when you picture the shot in your mind, note that the shadow extends directly forward, from the bow of the ship. This makes it a little easier for us, since we can simply extend the shape of the ship to create our shadow edge. (OK, so the shadows are at a slight angle. Let's keep it simple for now.)

- Load your ship or your Save Transformed pieces into one layer in Modeler. The Z axis will be the one to extend our shadow edge in, so expand the XY view and select all the points that are on the outer edge of your ship object.
- Cut and paste them in a different layer, which will form the basis of our shadow edge object (Figure 6). If your object is too complex you may want to delete every other point, since your shadow edge object doesn't have to be as detailed as your ship, and depending on camera distance, doesn't have to be precise. For most cases, the camera has to be a fair distance away anyway so that you keep the volumetric effect in frame.
- For the next part we'll need to use some common sense. Upon examination of the points in the scene, we can see we've pulled off more points than are necessary: points that are duplicated in the Z axis, points representing "nurnies" (a Ron Thornton word for the little tubes and whatnot sticking out on spaceships) and such. By exercising a little common sense and consideration, we can decide which nurnie points can be deleted and where the shadow edge for our ship object should begin.

In this spaceship example, there are several basic areas and depths that we can determine after a study of the locations of the points: the body of the ship itself, the two side thruster units (nacelles) and the support arms connecting the thrusters to the ship's body. In Figure 7, note that the group of points in groups (1) and (4) are indicative of the main body, group (2) represents the support arms, and groups (3) and (5) are from the thrusters. To simplify the shadow edge, we'll need to collapse the points onto a single plane, which ideally should be the frontmost edge of that particular group.

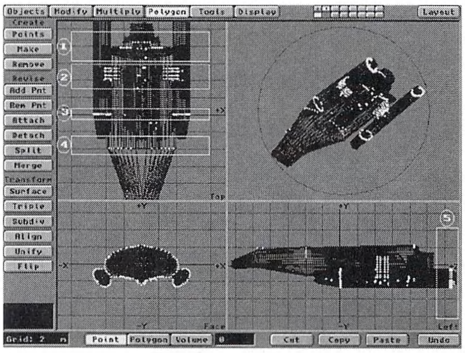


Figure 7: Point groups for the shadow edge

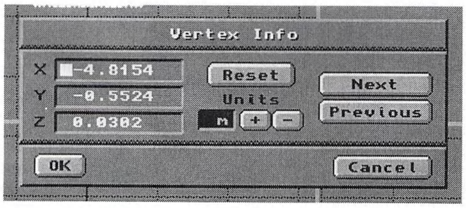
Collapsing Points

In looking at groups (3) and (5), we determine that the shadow edge should be at the front tip of the thruster, just before it begins to taper off.

- Selecting a random point from that tip, hit the (I) key. An Information panel pops up (Figure 8). Note the Z coordinate value for this point—in this example, it is 0.0302. Next, select all the points in groups (3) and (5) and hit (H) to Size. Click on the Numeric button and enter the following values in the requester:

  X Factor: 1
  Y Factor: 1
  Z Factor: 1
  X Center: 0
  Y Center: 0
  Z Center: 0.0302 (the value we retrieved from the Information panel)

- Hit OK, and all the selected points will collapse onto the front edge of the group. Do a Merge Points function (m) immediately, to eliminate any excess points. Repeat this procedure for group (2), then for groups (1) and (4). Note that the main body of the ship tapers off from the very rear of the ship, so the shadow edge begins almost from the rear (Figure 9).



X -4.8154
Y -0.5524
Z 0.0302

Figure 8: Information giving us the value for the Z axis

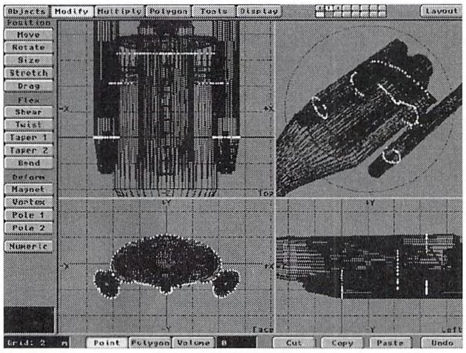


Figure 9: Point groups collapsed onto respective planes

Creating the Shadow Edge

Once we've cleaned up the points, we'll begin using them to make the shadow edge. Select the XY view again, and begin selecting points in order to create a polygon or polygons that encompass all your points (Figure 10). Because of the differing depths of our points, some of these polygons will be grossly non-planar and corrupt, but that's OK, as they are only the means to an end.

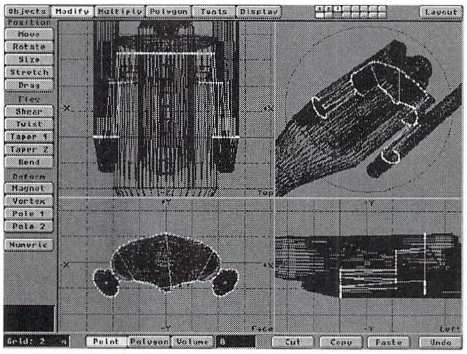


Figure 10: Points to polygons for the shadow edge

- Select the polygons at both ends of the shadow edge object and delete them, leaving your ship with a nice, hollow shadow edge. (Notice in Figure 11 that I'm a neat freak and had to collapse the far end of the shadow edge. This step isn't necessary.) Name the surface "Shipshadow" and Export your object to Layout.

In the Surfaces panel, select "Shipshadow" as the current surface and enter these surface settings:

Shipshadow surface

Surface Color	9,10,20
Luminosity	100%
Diffuse Level	0%
Transparency Texture	
Texture Type	Planar Image Map
Texture Image	Cookie.iff
Texture Axis	Z Axis
Automatic Sizing	
Texture Falloff	0,0,15.0
Texture Velocity	0.01,0.03,0
Edge Transparency	Transparent
Edge Threshold	0.7
Smoothing	On
Double Sided	On

- Save the shadow edge object again and parent it to your spaceship.

You now have a column of shadow edge extending from your ship. Using a dissolve envelope on the shadow column, we will be able to throw a volumetric shadow in time with our lens flares..

Building the Scene

To achieve believable CGI effects shots, you must be able to break any given scene down into its simplest elements. Our volumetric shadow works best only in certain circumstances, so we must accommodate its shortcomings and work around them.

In breaking down the sequence, I noted that I would need at least two lens flares to achieve the effect we are after. One of the flares must have Glow Behind Objects activated to provide the background flare behind the ship object. The other flare provides additional flare intensity and a central ring. Most importantly, with Glow Behind Objects turned off, the flare renders in front of the ship and shadow object, providing a flare "bleed" characteristic of lights in a fog.

Upon test rendering, however, I decided to give the flare a more prominent "hotspot" by simply adding one more flare.

The following flares were thus parented to a null and positioned behind the moon object (which, incidentally, is not to scale), and their values ramped up as the moon slides out of the way. Simultaneously, our dissolve envelope for the shadow edge is also ramped down from 100% dissolve to 0% dissolve so that the shadow edge is only visible at the time of the flare. After some test renders, these were the final values I settled on:

Light Name	SunGlowBehind
Light Color	255, 247, 214
Light Intensity	0.0%
Lens Flare Options	
Central Glow	On
Glow Behind Objects	On
(all other settings off)	
Flare Dissolve	0%
Flare Intensity Envelope Keyframes:	
Frame 0	70%, tension 0.86
Frame 54	140%, tension -0.21
Frame 67	300%, tension 0.96
Frame 77	290%, tension 0.27
Frame 150	70%, tension 1.0
Light Name	SunFlare
Light Color	255, 247, 214
Light Intensity	0.0%
Lens Flare Options	
Central Glow	On
Central Ring	On
(all other settings off)	
Flare Dissolve Envelope Keyframes:	

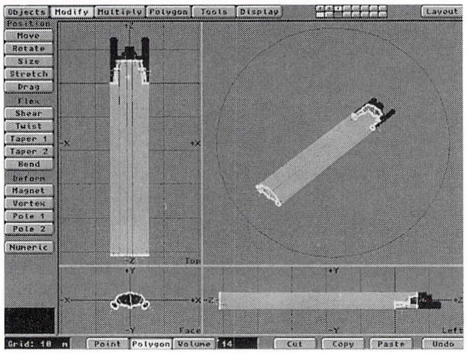


Figure 11: The extruded shadow edge

Frame 0	0%, tension 0.0
Frame 54	0%, tension 1.0
Frame 67	30%, tension 0.96
Frame 84	28%, tension 0.0
Frame 153	0%, tension 1.0
Flare Intensity Envelope Keyframes:	
Frame 0	0%, tension 0.33
Frame 54	10%, tension 0.75
Frame 67	300%, tension 0.96
Frame 80	290%, tension 0.27
Frame 153	70%, tension 1.0
Light Name	SunHotSpot
Light Color	255, 247, 214
Light Intensity	0.0%
Lens Flare Options	
Central Glow	On
Central Ring	On
(all other settings off)	
Flare Dissolve	0%
Flare Intensity Envelope Keyframes:	
Frame 0	0%, tension 0.45
Frame 54	2.5%, tension 0.86
Frame 67	105%, tension 0.96
Frame 82	105%, tension 0.27
Frame 153	35%, tension 1.0

Integrating The Background

One major drawback of this method is that the shadow edge works best against an empty space. If you try to add an object behind it, say a planet, the illusion of subtractive light is destroyed. (Try it and see.) A solution is to render the background elements separately and composite them into the scene, making sure to dissolve the background out at the peak of the flare. For our example, I simply attached a Dissolve Envelope to our background stars object and matched the dissolve to the flare. Figure 12 shows a rendered frame from the peak of the flare.

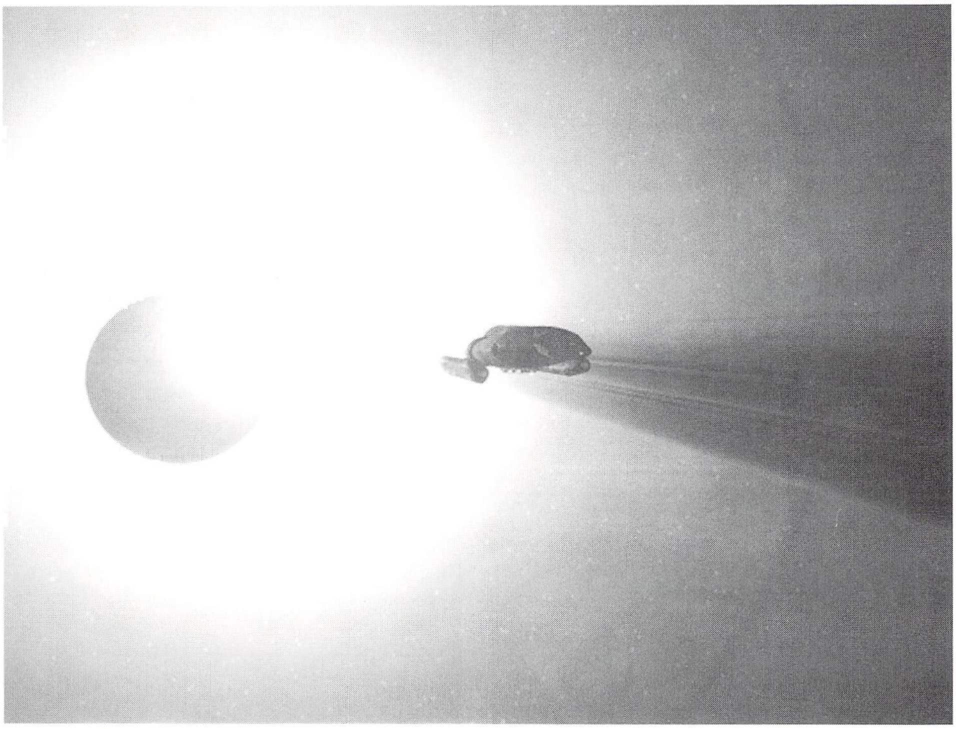


Figure 12: The results of the volumetric shadow edge

Trek On

Now that you're knee-deep in volumetric waters, take some time and try some more advanced tricks. Here are a few suggestions.

- Shadow Edges off of the axis: Estimate the angle and rotate your object in Modeler, taking care to note the exact amount of rotation on each axis. Copy your points and extrude. Export to Layout, surface, parent to object and enter negative rotation values for the shadow edge keyframe.
- Glow Behind Objects: Note that the Glow Behind Objects option renders the flare parallel to the visual plane—that is, if your flare is the same distance from the camera as another object, the flare will appear to cut through the object. You might wish to use this to your advantage. Remember that a Glow Behind Flare cannot be located between an opaque object and a transparent object. In this case, the transparent object will be rendered solid while in front of the glow behind.
- Custom Cookies: Aside from using a standard cutout pattern, consider using individual cookie patterns for different projects. Use a paint program to create gradients and slices to integrate into your shadow edges. You may one to consider animated patterns as well.

Every shot is different and every effect requires a new approach. Hopefully, these concepts will inspire you not just to re-create this effect, but to experiment and come up with your own examples of volumetric lighting. As we stand on the bleeding edge of the digital future and stare out at the glorious sunrise that started all this volumetric thought, just remember these words an ancient sage once said: it takes vision to create.

LWP

Alan Chan is having digital visions again. Be nice and e-mail him at alan.chan@oubbs.telecom.uoknor.edu, or call Vision Digital at (405) 447-707

What's on the Disk:

This month's *LIGHTWAVEPRO* disk includes scenes files, objects and images from Alan Chan's volumetrics article, plus some surfaces by Enrique Muñoz. Also included is the disk contents mentioned in June's issue.

LightWave Tech

continued from page 5

moved, and found the files you wish to move, just implement one of two commands: GET or MGET.

GET and MGET are both FTP commands for transferring files from the remote system to the local systems home directory. The main difference between them is that MGET is for "getting" multiple files, while GET is for a single file. Another difference is that you can use the * wildcard with MGET, while GET wants to find the actual filename entered. Most of the time you will want to move more than just one file, and thus be using the MGET command. However, there is a slight problem with MGET, in that you must verify every file selected for transfer. That is, if you have 100 files named Image001, Image002, Image003, and so on, and you use MGET with the wildcard filename of Image*, the FTP window will prompt you MGET Image001?. Hitting enter without entering anything will accept, hitting no, or N will cancel that files transfer and then prompt for the next file that meets the wildcard specs. Even though this seems like a real pain in the #$!, it is somewhat less of a problem due to the fact that computer systems contain keyboard buffers that hold the last keystrokes made until the system is ready to process them. That means that, though you do have to hit the enter key for every file, you can load up the buffer with a number of return keystrokes so that as soon as the system prompts for the next file, the enter key to accept it is already waiting in the buffer, which actually speeds up the process a little. Then, once some of the files have begun transferring, just load up the keyboard buffer with a few more returns.

Although this sounds like a lot of work, it really isn't once you've done it once and see just how easy it really is. Besides, if you want a less complicated connection, it will require quite a bit more money and time to set up, which really isn't worth it if you only have a few frames, or a few hundred for that matter.

So, what solution is best for you? If you are abandoning your Amiga in favor of a newer machine, you'll only need the "one-time" transfer of your files. If you are going to be using your Amiga along with your new machines, you need to figure out how much transfer you are going to do. If it's just a few files at a time, the floppy based system works just fine, If you need more powerful networking solutions, you may want to take a look at making your Amiga a permanent part of your home network.

Phillip Hice is the head of Amblin Imaging's technical department and is responsible for (among other things) keeping 33 Alpha workstations and the last of Amblin's Amiga rendering farm on-line.

Editor's Message

continued from page 3

last time, so I tried using the current one. NT said it was successfully installed and I needed to reboot. Once again, after restarting, I got the message stating that a previous configuration was being used, and when I re-entered the backup program, NT couldn't find the drive.

OK, now I wasn't having fun anymore. It was time to get serious and perform an NT repair. After going through the process of running the repair, I was informed that everything was cool, so I went ahead and reinstalled the driver for the tape drive (again) and tried to run the software. No go. By this time it was pretty late, I was extremely frustrated, and I decided to just reinstall NT from scratch. So I did. Again, it didn't work. And this time, with the fresh install, I lost the drivers for my graphics card and my driver for the LightWave dongle. In addition, I was having the same problems trying to get them to re-install. I went to bed mad!

I had now advanced past my PC knowledge, and it was time to call in the big guns. I packed up my system and took it to work with me the next morning. Phillip Hice, after laughing at me, suggested I take out my hard drive and back it up to the net (convenient, that). So I now had a partially backed-up drive (I lost some data on reinstalling NT the night before). I did a fresh format of the drive and reinstalled NT. Same problems. I did an NT repair. Same problems. I reinstalled NT. Same problems. I re-installed NT again. Same problems again. Next, I tried a new SCSI adapter/controller. Same problems. Different hard drive. Same problem. Nothing I tried worked. No matter what I did, NT would not recognize any new driver installations, and every time my system started up, it would act as if these was a first-time NT install and set security on system files (this happens only the first time you reboot after an NT install). I was hosed.

By this time I had figured out it was my motherboard. I had already tried two different hard drives and two different SCSI controllers, so what else was left? I decided it was time to call tech support and get my motherboard replaced (after all, they had replaced Tony Stutterheim's and his machine now seemed to be working).

Talking to IBM tech support was nothing if not frustrating. "[We] could replace the motherboard, but it sounds like something with NT. Of course, we don't have anybody here that really knows NT, so how about if you call Microsoft?"

Oh boy. I did not want to have to go through that. And it turns out I didn't need to since Microsoft doesn't have any tech support. At least nothing that costs less than $150 per year. Of course they did, but that special offer expired at the end of 1994. The best I could get out of Microsoft was a fax-on-demand for a bunch of different problems (except mine, of course).

Sooo, back to tech support. I called them and told them that Microsoft said it may be hardware-related, but they couldn't tell me for sure because this particular system wasn't on the NT compatibility list. (Doesn't that sound like something Microsoft would say?) They told me to bring my computer in, but I would have to leave it for three days.

As we established earlier, I'm not entirely stupid, so I decided to mark my motherboard in some unnoticeable places and write down serial numbers of BIOS chips just to make sure my board actually got replaced. I did so and hauled it off to the dealer.

Of course, all of this happened at the worst possible time. I was on the tail end of finishing up the LightWave Layout User's Guide and really needed a system. Thankfully, Carrera Computers loaned me a demo Alpha workstation that has been a godsend (I'm writing this on it now!)

Finally, after falling ill for a week, I went to pick up my computer. On a piece of paper taped to the box (not a work order) it said "Replaced M.B." I took it back to work, hooked it up, and voilà!, same problems. Remembering that I'm not entirely stupid, I removed the case cover and looked at the motherboard. There were all of my little markings—just as I'd left them! All chips were the same as well. Nice. Boy, this makes me happy.

So now I'm cooking up this little scheme to first get the dealer to send me some real paperwork stating that they replaced the motherboard. Why didn't I get any paperwork when I picked it up? Remember, I just said I'm not *entirely* stupid. I called them and told them I need some paperwork stating that it was repaired for the business insurance that was paying for a "rental" computer while mine was down. I hope they buy it so I can go back and find out why they said they replaced the board but didn't. And get a new board from them and then never (hopefully) deal with them again.

So, what have I learned from all of this?

I've found that dealing with PC vendors is like dealing with car repair people. It sucks if you don't know anything about your equipment, but eventually, you're going to have to deal with it. I've also learned that finding somebody that knows a good amount about PCs is like finding a good mechanic: you should learn to trust their judgment and seek out their advice.

I'll let you know what happened next month.

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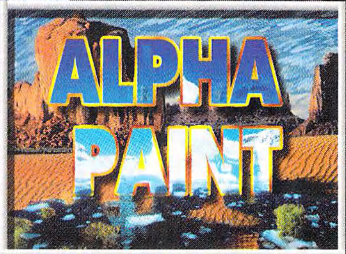
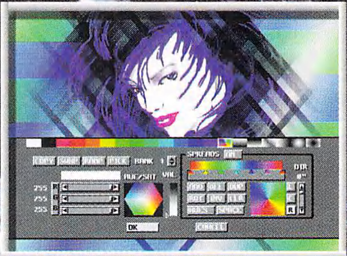
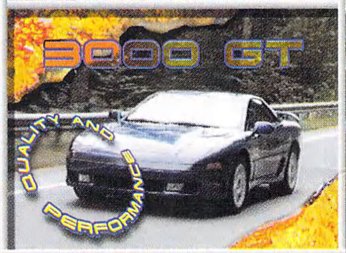


Texture Mapping



Intuitive User Interface



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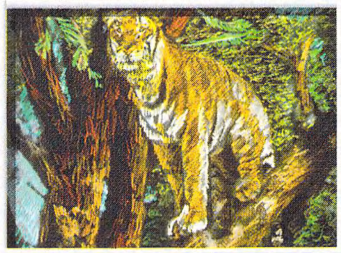

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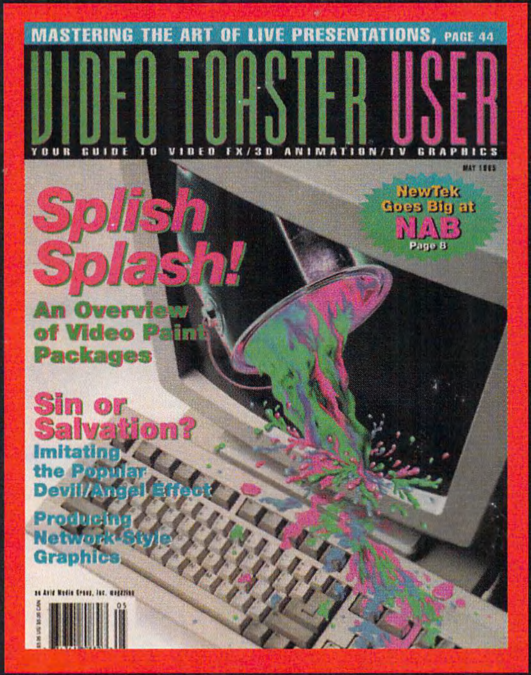

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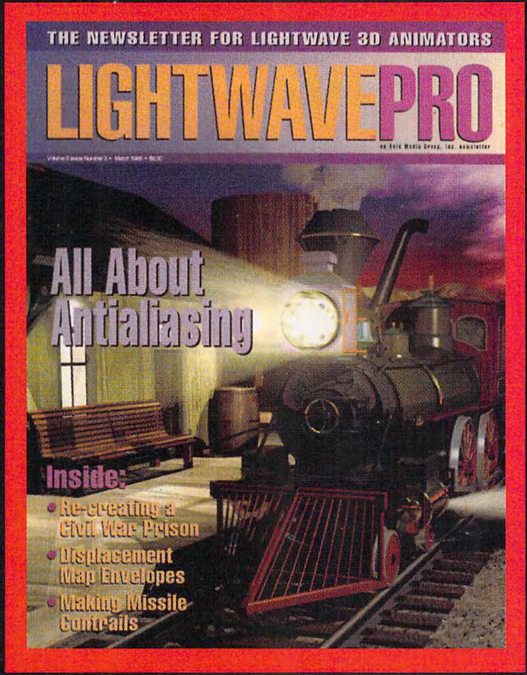

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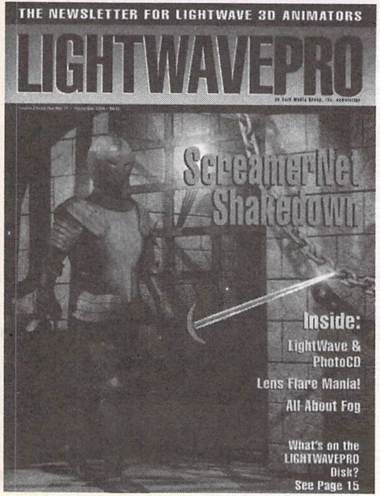
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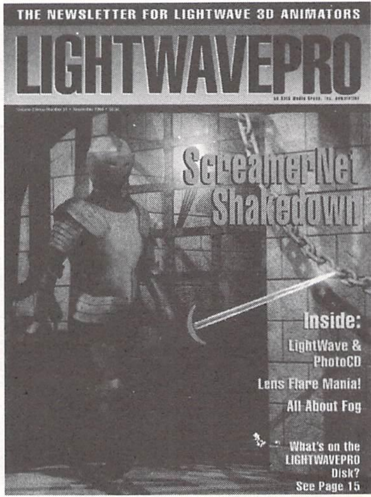
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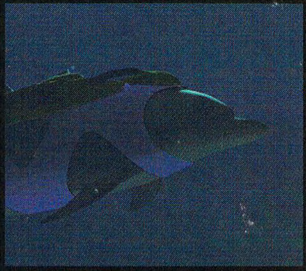

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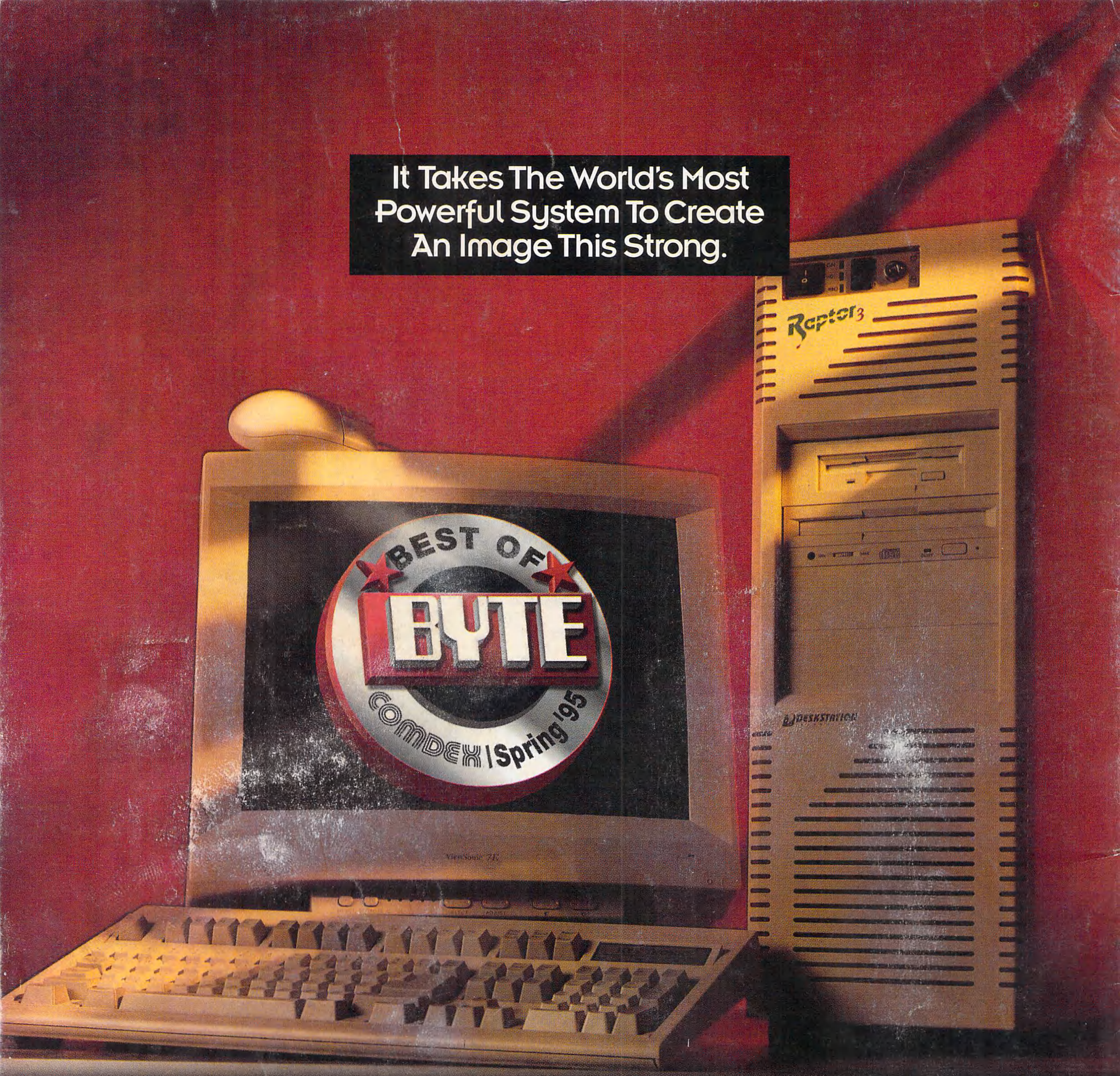
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